SECTION IV

SEABIRDS

Chapter I

Distribution, Numbers, and Population Movements

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16. Abstracts (Volume 1, Executive Summary, not available from NTIS)

This volume is a compilation of the principal investigator's reports form the first year of a three year study on the distribution, abundance, and movements of seabirds in the Southern California Bight. Reports on first year studies of foods, foraging ranges and reproductive ecology of seabirds are presented. Data collected from 12 monthly beached bird surveys along 18 Southern California beaches are also presented.

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SECTION IV – SEABIRDS

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III. BIRDS: Distribution, Numbers and Population Movements

A. Introduction

This report presents the results of studies conducted in 1975-76 concerning the numbers, distribution, nesting status, and population movements of the marine birds of southern California. These studies are designed to establish a baseline of information that may be used to predict and monitor the effects of Outer Continental Shelf (OCS) resource exploration and exploitation on this group of organisms.

The marine bird community of southern California is likely to be among those most visibly and seriously affected by environmental alterations due to offshore resource development. Marine birds have proven to be particularly susceptible to the effects of pollutants such as oil (Bourne 1970, Straughan 1971, Smail et al. 1972, Ainley and Lewis 1974) and chlorinated hydrocarbon-based pesticides (Risebrough et al. 1967, Anderson and Hickey 1970, Gress 1970, Gress, et al. 1971, Schreiber and Risebrough 1972, Gress, et al. 1973, Coulter and Risebrough 1973).

Many species of marine birds, particularly cormorants and pelicans, are also highly vulnerable to direct human intrusion in their breeding colonies. With the increasing exploitation of the offshore waters and islands of southern California for recreational and commercial uses, the birds using these islands for nesting and

the surrounding waters for foraging will be subject to impacts which may further endanger the stability of their populations. The mere presence of people and equipment in or near colonies may precipitate complete reproductive failure.

Considerable research has been conducted on the effects of both acute and chronic, low-level oil pollution on seabirds that nest or winter along the coasts of Britain and northwestern Europe. These studies have demonstrated the great vulnerability of loons, grebes, diving ducks, and auks to oiling. The particular vulnerability of these species is due to their tendency to aggregate in large numbers in winter, the large amount of time they spend on the sea surface, and the fact that they all dive to obtain food (Phillips 1967, Greenwood and Kedie 1968, Bourne 1970, Vermeer and Anweiler 1975). One or more of these groups of birds have often comprised 75% of the total dead, oiled birds washed ashore following major oil spills at sea (Clark 1973). This author and Ainley and Lewis (1974) have emphasized the importance of chronic, low levels of oil pollution in long-term population declines of vulnerable species in European and California waters, respectively. Numerous small oil slicks in a circumscribed section of coastal waters, over a span of several years or decades, appear to have detrimental effects equal in magnitude to those attribtued to acute pollution of a similar sort (tanker wrecks, platform blowouts) (Bourne 1968, Bourne and Devlin 1969, 1970, 1971, Clark 1973).

The apparent effects of one large-scale oil spill on marine birds were discussed following an oil platform "blowout" in Santa Barbara Channel in 1969 (Straughan 1971). That report concluded

that perhaps 3,600 oiled birds were cast ashore. The California Department of Fish and Game estimated that 12,000 birds were present in Santa Barbara Channel at the time of the spill. However, Connell (1971) later pointed out that the magnitude and long-term nature of effects of the Santa Barbara spill were impossible to ascertain, because the status of marine birds in the area was poorly known prior to 1969, and the reliability of surveys conducted after the spill was not determined. In other words, an adequate base of data did not exist prior to or after the spill. Connell stated that the minimum information necessary to assess the impacts of such occurrences in the future must include up-to-date knowledge of the numbers, kinds, and status of birds in spill areas prior to the onset of oiling, and, if possible, similar data over larger geographic areas through time. These data must be collected using the best methods available; they must be replicable by different observers, and ideally should contain information about the accuracy, precision, and applicability of the impact assessment methods themselves.

The problem of establishing an adequate data base is made more complex by the highly mobile nature of marine birds. It does not suffice to document bird numbers in the immediate vicinity of offshore development sites while ignoring other areas. Marine birds move extensively from day to day and may traverse hundreds or thousands of kilometers in the course of a two- to eight-month migration. Because of this mobility, the environmental changes wrought by offshore resource exploitation in southern California waters may dramatically affect the size, composition and health of

breeding communities as far as the Arctic or Australia. Thus, a truly adequate baseline study must include information about birds in the areas adjacent to actual development sites, provide data about seasonal and year-to-year variability in populations, and contain information relevant to the ecological position of migrant species from other geographic areas and ecosystems.

According to Aldrich (1970) "correlating numbers of birds lost from breeding colonies with numbers involved in oil spills is a better method [than at-sea correlations for estimating the effects of a spill], but this may take a number of years and may be confounded by other factors that affect abundance." Milon and Bougerol (in Vermeer and Vermeer 1974) in 1967 documented changes in the populations of seabirds nesting on the Ile Rouzic in France subsequent to the *Torrey Canyon* oil spill disaster. In less than a month, the Atlantic Puffin (*Fratercula arctica*) population was reduced from about 5,000 pairs to 600 pairs due to oil-related mortality. Similarly, Razorbills (*Alca torda*) were reduced from 400 to 50 pairs and Common Murres (*Uria aalge*) from 400 to 100 pairs. In contrast, gulls (*Larus marinus*, *L. argentatus*, and *L. fuscus*) decreased only 10% and of 40-50 Fulmars (*Fulmarus glacialis*), only 2 birds were stained. Other studies have shown marked effects of oil on breeding alcids and gannets (O'Connor 1967, Phillips 1967, Monnat 1967, all in Vermeer and Vermeer 1974). For lack of adequate baseline data on numbers and timing of breeding, Phillips (1967) was unable to determine what effect the spilled oil had on other colonies.

Two lessons to be learned from the Torrey Canyon disaster

are that different species of nesting birds are affected by oil to different degrees, and that baseline information on numbers and timing of breeding is necessary if the impact of offshore oil-related activites is to be ascertained.

1. Overview of relevant literature

The efforts of earlier workers to record and interpret the distributional status of the marine birds of southern California resulted in fairly adequate historical data (and, in some cases, breeding phenology) for a few major breeding sites on the Channel Islands and the southern California mainland. The sizes of nesting colonies were not well documented, nor was much quantitative information gathered concerning distribution of birds at sea. Howell (1917) produced the first noteworthy account of the species found on the Channel Islands, primarily a statement of status, distributional limits, and nesting behavior of terrestrial and water birds. Willett (1933) updated Howell's treatment with new records of similar nature, as did the comprehensive work of Grinnell and Miller (1944). Banks (1966) and DeLong and Crossin (1968 ms) provided further detailed information about the breeding species of the Channel Islands.

In addition to the published material, much useful information of breeding colonies can be extracted from the unpublished notes and egg and specimen data slips of numerous oologists and museum personnel who visited the islands during the past eighty years.

Prior to this study, data concerning distribution, species

composition or numbers for birds at sea in the Southern California Bight were almost nonexistent. Grinnell (1897), Howell (1917), Pemberton (1928), Willett (1933), Sefton (1934) and Miller (1936) provide early accounts of limited scope. More recently, seasonal accounts by Small (1951 to 1963) and McCaskie (1963 through 1976) and the more comprehensive discussions of distribution of Pyle and Small (1961) and Jehl (1973) have added considerably to our knowledge of the seasonal distribution of marine birds. These authors have recognized that certain areas between the nearer Channel Islands often support large numbers of birds. Tanner and Cortés Banks, Lasuen Knoll, and Fortymile Bank have also been identified as areas where pelagic migrants often congregate. Data gathered from these places during organized bird-watching cruises are useful in providing a basis for comparing yearly migration patterns and, in some cases, assessing relative numbers of birds.

In 1967-68, an attempt was made to clarify distributional patterns and seasonal status of marine birds of the southern California region away from their breeding grounds. In those years, the personnel of the Pacific Ocean Biological Survey Program (POBSP) recorded observations from 150 to 500 km off the coast of southern California, between the latitudes of 32°N and 35°N. They also made notes on the birds encountered en route to and from their pelagic study area. The results of these POBSP studies are collected in a number of unpublished manuscripts on the "Eastern Grid" and in distributional accounts of several species that breed in or migrate through southern California waters (King (ed.) 1974,

Harrington 1975, and manuscripts on file at the Smithsonian Institution). The POBSP work was followed with observations by Jehl (1973) in the fall of 1971, out to and along the continental edge.

Data on seasonal and geographic distribution of seabirds comparable to those presented here exist for only a few locations. The large-scale distributional accounts of Pacific and Canadian seabirds (King 1970, King (ed.) 1974, Brown et al. 1975) cover much larger geographic areas and differ in their methodology. The data of Wiens and Scott (1975) perhaps bear the greatest resemblance to our own, and many of the seabirds discussed by these authors also occur in southern California waters. Recent summaries of some of the pertinent literature on the marine avifauna of southern California are contained in reviews by Scott (1974) and Bender, Collins and Warter (1974). Neither presents original information, but in the former, a discussion of possible impact stemming from offshore petroleum exploitation on marine and coastal bird populations is included.

2. The study area

The southern California continental borderlands region includes approximately 53,000 km^2 of open ocean and coastal waters, nine islands or island groups (including the eight California Channel Islands and Los Coronados), and about 450 linear km of mainland coastline. Seabirds utilize a diverse array of habitats within the area: coastal and island cliffs, beaches, nearshore waters, interisland channels, waters overlying offshore banks, ridges and

basins, and oceanic waters of the California Current beyond the edge of the continental massif.

The general oceanographic characteristics of the waters off southern California were recently reviewed by Jones (1971). Three major features of the area's current patterns and nutrient cycling regimes are of broad importance in the seasonal species patterns and species composition of the marine avifauna. Among these features are the relationship of the cool, southward-flowing California Current to the coastline and offshore ridges, the presence of a relatively warm water backflow inshore of the California Current, and strong, seasonal upwelling along the western border of the study area. These conditions lead to both large-scale latitudinal and longitudinal gradients in surface temperatures and nutrient availability and to complex, small-scale anomalies, such as local gyres and downstream mixing related to sea floor topography and the presence of islands. These oceanographic phenomena are correlated with seasonal changes in seabird composition and abundance and lead to fluctuations in the presence and availability of seabird food resources. Changes in "normal" oceanographic patterns may also relate to periodic anomalies in bird behavior, such as local reproductive failure, establishment of new colonies, etc. The interrelations of seabirds and their environments are reviewed by Ashmole (1971). Ainley and Lewis (1974) present an historical analysis of the effects of long- and short-term fluctuations in current patterns on the abundance of seabirds that breed in central and southern California.

3. Organization of baseline studies

This work was divided into two major subprojects, one dealing with birds that nest in the study area, the other with birds that occur as non-breeding visitors or migrants.

One aspect of the study was to determine the species of marine birds nesting on the islands in the Southern California Bight in 1975 and to record their population sizes and colony location. We have collated all historical information available to us on colony sizes and locations (Appendix III-A3) in an effort to contrast present-day populations with those of the past and detect any significant changes that may have taken place. Studies of the nesting seabirds which are included in this report were conducted between 17 April and 18 July 1975. Data gathered during colony surveys since then will be included in the 1976 Contract Report.

The second aspect of the study was to determine the status and seasonal dynamics of the non-breeding marine birds in the open ocean and on island and mainland beaches of the Bight. Included are discussion of species composition, density distribution, behavior and seasonal population movements in the area between 32°20'N, and 34°30'N, east of 121°W. Our open-ocean sampling program was organized into three phases. The first was the quantification of species encountered along predetermined, constant, straight-line transects spaced evenly throughout the Southern California Bight.

Additionally, major environmental data were collected at regular intervals. In the second phase, multiple regression

procedures were used to provide means of stratifying the study area according to environmental features that influence or correlate with avian density. In phase three, we will extrapolate from sampled to non-sampled areas, producing estimates of the total area abundance of marine birds according to taxon and to season. At the end of the first year of baseline studies we are entering the second phase.

In addition, we gathered data on the occurrence and behavior of seabirds on and near the shores of the California Channel Islands and southern California mainland. This work included onshore and shipboard counts along selected beaches and in nearshore waters, plus airborne observations and photography of roosts and nesting areas.

B. Methods

1. Seabird colonies

Our census techniques varied with the species concerned, colony size and island terrain (Table III-110). In no case did we attempt to get better counts at the risk of disrupting normal colony functions. Whenever possible, direct counts of active nests were made. In other cases (usually with Western Gulls) territorial pairs were counted. In such instances counts were made at, or shortly after, dawn when the greatest number of birds was likely to be present. Where direct counts were not feasible, nest density was estimated by one of two methods. The first consisted of counting every nest within _n_ meters of several line transects through the colony. The second consisted of counting all nests in selected quadrats of predetermined size. In both cases the average nest

Table III-110. Methods used to determine the number of seabird pairs breeding on the California Channel Islands in 1975.

Symbols for species: PTAS = Ashy Storm-Petrel (Oceanodroma homochroa);
PELB = Brown Pelican (Pelecanus occidentalis);
COD = Double-crested Cormorant (Phalacrocorax auritus);
COB = Brandt's Cormorant (P. penicillatus);
COP = Pelagic Cormorant (P. pelagicus);
GUW = Western Gull (Larus occidentalis);
GP = Pigeon Guillemot (Cepphus columba);
MLX = Xantus' Murrelet (Endomychura hypoleuca);
AKC = Cassin's Auklet (Ptychoramphus aleuticus);

Other symbols: 1 = direct count of nests (1^a = aerial count); 2 = count of pairs on territory; 3 = estimate by quadrat method; 4 = estimate by transect method; 5 = estimate by count of chicks; 6 = other (see text). ? = see 1975-76 data.

	Species								
Island	PTAS	PELB	COD	COB	COP	GUW	GP	MLX	AKC
1. San Miguel Is.				1	1		6		
Castle Rk.				1	1		6		?
Prince Is.			2	1	1	2	6	?	3
Richardson Rk.									
2. Santa Rosa Is.				1^a					
3. Santa Cruz Is.									
Gull Is.				1	1	1			1
Scorpion Rk.		5,6				5	5		
4. West Anacapa Is.		6		1	1				
4. Middle Anacapa Is.						2			
4. East Anacapa Is.						2			
5. San Nicolas Is.				1		4			
6. Santa Barbara Is.			1	1	1	2	6	3,4,6	
Sutil Is.			1	1			6		
Shag Rk.									
7. Santa Catalina Is.									
Bird Rk.						5			
8. San Clemente Is.				1		?			
Castle Rk.				1					
Bird Rk. (NW Harbor)						1			

density per $\underline{n}^2$ meters was multiplied by the total colony area to derive the approximate number of breeding pairs present.

Pigeon Guillemots presented a special problem. Since their nests are hidden from view and generally inaccessible, we arbitrarily took the number of birds seen on the water below an undisturbed colony as our estimate of the number of breeding pairs present. During the incubation period, assuming that all birds present at a colony are paired and breeding, the number of birds on the water should equal the number sitting on eggs (thus, 1 bird counted = 1 breeding pair). This number, however, is undoubtedly overrepresentative of the true number of breeding pairs since an unknown fraction of the birds in a given colony are likely to be unmated. As the breeding season progresses the number of birds seen on the water below a colony increases, presumably due to the increasing number of birds with young which need not be continuously attended by a parent. In the future it would be preferable to count pairs of birds on the rocks in March prior to egg-laying (see Ainley and Lewis 1974).

Cormorants could usually be counted directly; however, most Double-crested Cormorant nests on Prince Is. could not be seen from the water, nor from land without approaching within a few meters of the colony. To avoid flushing the cormorants from their nests and leaving their eggs or young vulnerable to gull predation, we made estimates of the number of nests by observing birds from a distance as they commuted to and from their nests. We were unable to separate Double-crested Cormorants from Brandt's Cormorants in aerial photo-

graphs of the colony.

The number of active Cassin's Auklet burrows (N) on Prince Is. was calculated by the following equation:

$$\left(\frac{A}{A + I}\right) \cdot T = N \qquad (1)$$

where A is the number of burrows known to be active, I is the number known to be inactive and T is the total number of burrows present, including those whose contents or recent usage could not be determined. The estimated number of pairs breeding on the island is given as the calculated number of active burrows/meter^2 (quadrat method) times the total area containing burrows.

Estimates of the numbers of breeding Xantus' Murrelets and Ashy Storm-Petrels on Prince Is. were not made due to the inaccessibility of their nesting sites. Given additional time and resources a crude Lincoln index estimate could be made using mist-nets to capture birds coming into the colony at night to determine the percent of previously captured birds recaptured on subsequent dates.

2. Open-ocean surveys

a. Aerial observations

We conducted eight aerial surveys of the Southern California Bight in a Cessna 337 Skymaster (a high-wing, twin-engine aircraft) as shown in Table III-111. The standard census tracks used for these flights followed lines of longitude from the mainland, seaward to 32°20'N latitude and from 117°30'W to 120°30'W at intervals of 30' (Fig. III-173). Several lines were added during the course of the study to utilize commute time between primary census tracks;

Table III-111. Summary of aerial transect coverage of seabirds, May 1975 - March 1976.

Flight	Date	Km flown	Km^2 censused*	Transects flown
		Extent of coverage		
101	16-17 May 1975	285	14.3	Lines 118°00'W, 118°30'W
102	27-30 June	1096	54.8	All longitudinal lines
103	4-7 August	1933	96.7	All longitudinal lines plus latitudinal lines 32°20'N (all), 32°30'N (part), 33°00'N (part) 34°04'N (part), 34°15'N (part), plus northern Santa Rosa-Cortés Ridge.
106	23-26 October	1976	98.8	All longitudinal lines (118°00'W & 120°00'W non-standard); all latitudinal lines (32°20'N (partial), plus SNI-SBI.
108	16-18 December	1056	52.8	Longitudinal lines 117°30'W, 118°00'W (part), 118°30'W, 119°00'W (part), 120°30'W (part); latitudinal lines 32°20'N (part), 33°28'N, 33°54'N (120°00'W to 118°30'W twice), 34°18'N (part).
109	6 January 1976	633	31.7	Longitudinal lines 119°30'W (part), 120°00'W (part), 120°30'W; latitudinal lines 33°54'N (120°00'W to 118°30'W), 34°00'N (120°30'W to 121°00'W and return), 34°18'N.
110	22-25 January	2072	103.6	All longitudinal lines (longitudinal lines 118°00'W, 120°00'W and 120°30'W, part); latitudinal line 32°20'N part and 34°18'N; non-standard longitudinal lines 117°50'W, 119°50'W (part), & 120°20'W (part); non-standard latitudinal lines 33°20'N (119°50'W to 120°30'W) & 34°18'N (120°20'W to 121°00'W).
112	12-14 March	1093	54.7	All transect lines (partial coverage on longitudinal lines 118°00'W, 119°30'W, and 120°00'W & on latitudinal line 32°20'N).

*Km^2 censuses = Km flown x 0.05

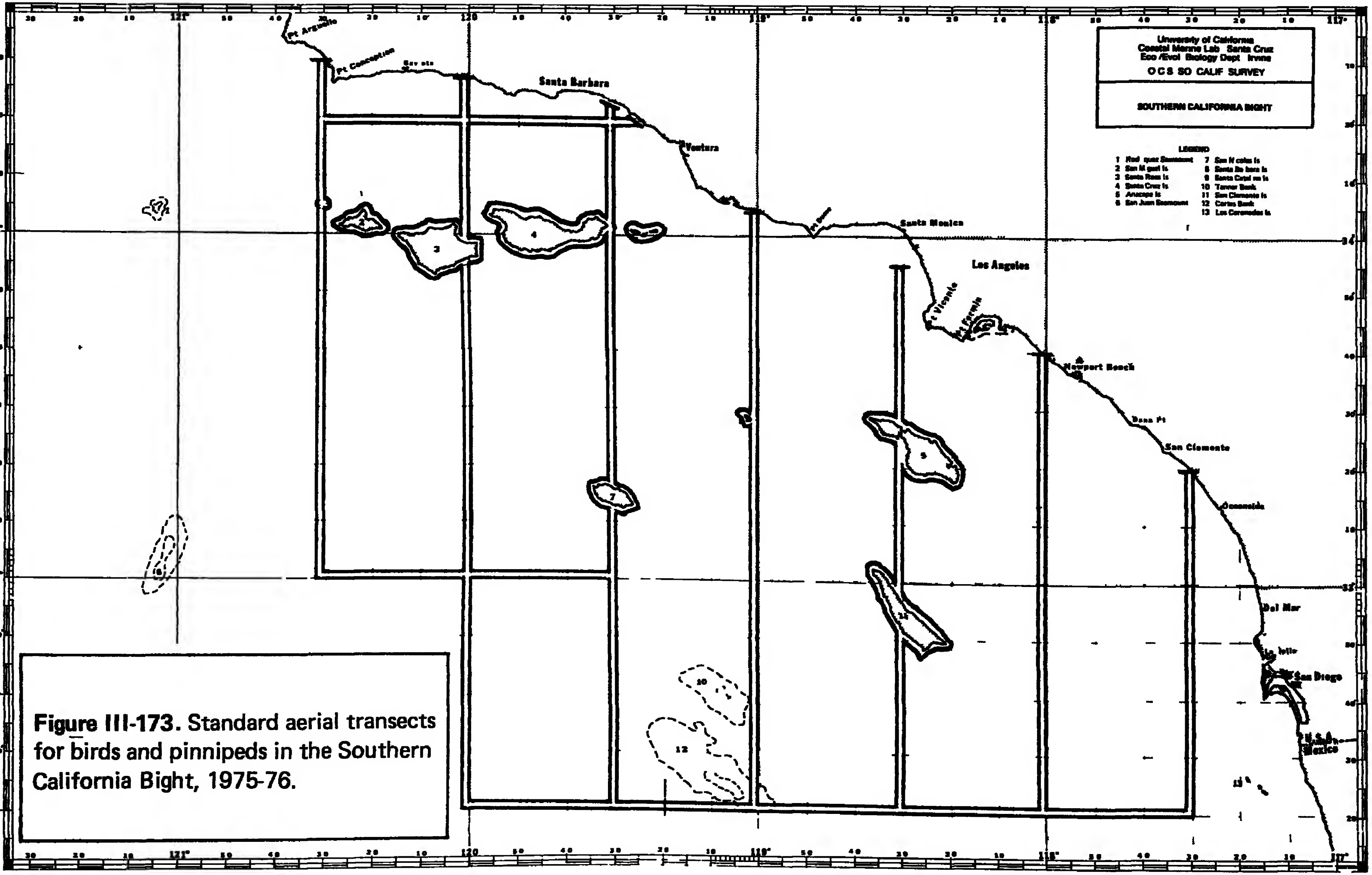

Figure III-173. Standard aerial transects for birds and pinnipeds in the Southern California Bight, 1975-76.

these were flown on an opportunistic basis. The starting point and progress on census lines were functions of weather, military activity and around-island surveys. No consistent sequence of transects within a flight series was followed.

Transect lines were divided into segments 10' of latitude in length (18.52 km). A field numbering system identified each segment by the latitûde and longitude of its southern endpoint. Segments ended on each 10' of latitude (e.g. 32°20'N, 32°30'N, and so forth). We flew at approximately 165 km/hr at altitudes of 60 to 75m ASL (both barometric and radar altimeters were used). The survey aircraft occasionally left the transect line to document large or interesting flocks, to photograph birds or mammals, or to investigate other items. The line was rejoined by flying a reciprocal course.

Except on one occasion the flight crew consisted of two bird observers, one pinniped observer, and the pilot. Only one bird observer was aboard for two days in January 1976. Observers rotated watches, which consisted of one complete transect line of 112 to 222 km, a procedure necessitated by the fact that observations were not feasible on the sunlit side of the aircraft due to glare and eye fatigue (observations were made by the person on the shaded side of the airplane). The off-duty observer served as navigator and back-up photographer.

Data records included time and location of bird sightings, species and numbers sighted, behavior, direction of travel, and interspecific associations. Environmental data were recorded at 1/2 to 1 hour intervals or as changes in conditions warranted. Cloud cover and

cloud type, wind direction and speed, and swell and sea height and direction were also recorded.

Identifications were made at the specific level whenever possible. If a bird could not be identified to species with confidence, it was recorded at the generic, or higher, level. Thus, depending on the physical characteristics of a sighting, a Xantus' Murrelet, Endomychura hypoleuca, may have been identified as "unknown alcid," "small alcid," "murrelet species," or "Xantus' Murrelet." In practice, the proportion of specific to generic identifications was highest among large or conspicuous birds and lowest for inconspicuous species groups in which similarities of plumage or flight characteristics rendered specific identification difficult. Examples of the latter were some terns, storm-petrels, small alcids, and immature gulls.

When birds were spotted in flocks so large that direct counting was not possible, observers first estimated numbers, then species composition, and finally, noted behavior, direction of travel, etc.

We recorded all birds sighted in a 50 m wide corridor on one side of the aircraft. Approximately 15° of visual angle from the vertical was obstructed by the aircraft fuselage. Thus, observers counted birds between approximately 15° and 45° from the vertical. Sighting angles were estimated and periodically checked with an inclinometer or with marks drawn on the interior of the cabin. Variation in estimation of corridor width was on the order of ± 10 m. Oscillations in aircraft altitude accounted for much of this error.

We feel that errors in estimating the lateral limit of the corridor average out over 5 to 10 km of the census track, resulting in a reliable estimate of the area surveyed. A corridor of 18.52 km linear extent (one segment) encompasses 0.93 km^2 of surface area.

Field notes were recorded on a Sony portable cassette tape recorder and were later transcribed and edited. Bird sightings were coded and entered onto magnetic tape for computer analysis and permanent storage.

Avian density was calculated monthly for each species for 10' blocs of latitude and longitude. Age categories, behavior, etc. were analyzed separately as required. Estimates of replicability and variance of this aerial survey technique are discussed below and in Appendix III-A2 . In general, aerial transects provided us with an accurate, immediate assessment, relatively unaffected by sea state conditions, of gross avian composition and density over the widest possible area.

b. Ship observations

We conducted seven complete and two partial transect surveys from ships in the waters inshore of the Santa Rosa-Cortés Ridge. Each of the surveys required six ship-days and covered 726 linear km. The standard cruise track is presented in Fig. III-174. In additon, we sampled bird density and composition on a number of tracks between island nesting colonies in spring and summer, 1975 and winter, 1976. Table III-112 indicates the type and geographic extent of shipboard censusing in the study area in 1975-76.

Ship census tracks were divided into watch segments of 7.4 km (4 NM). Ship speed was usually 22 km/hr (less frequently 15-18 km/hr).

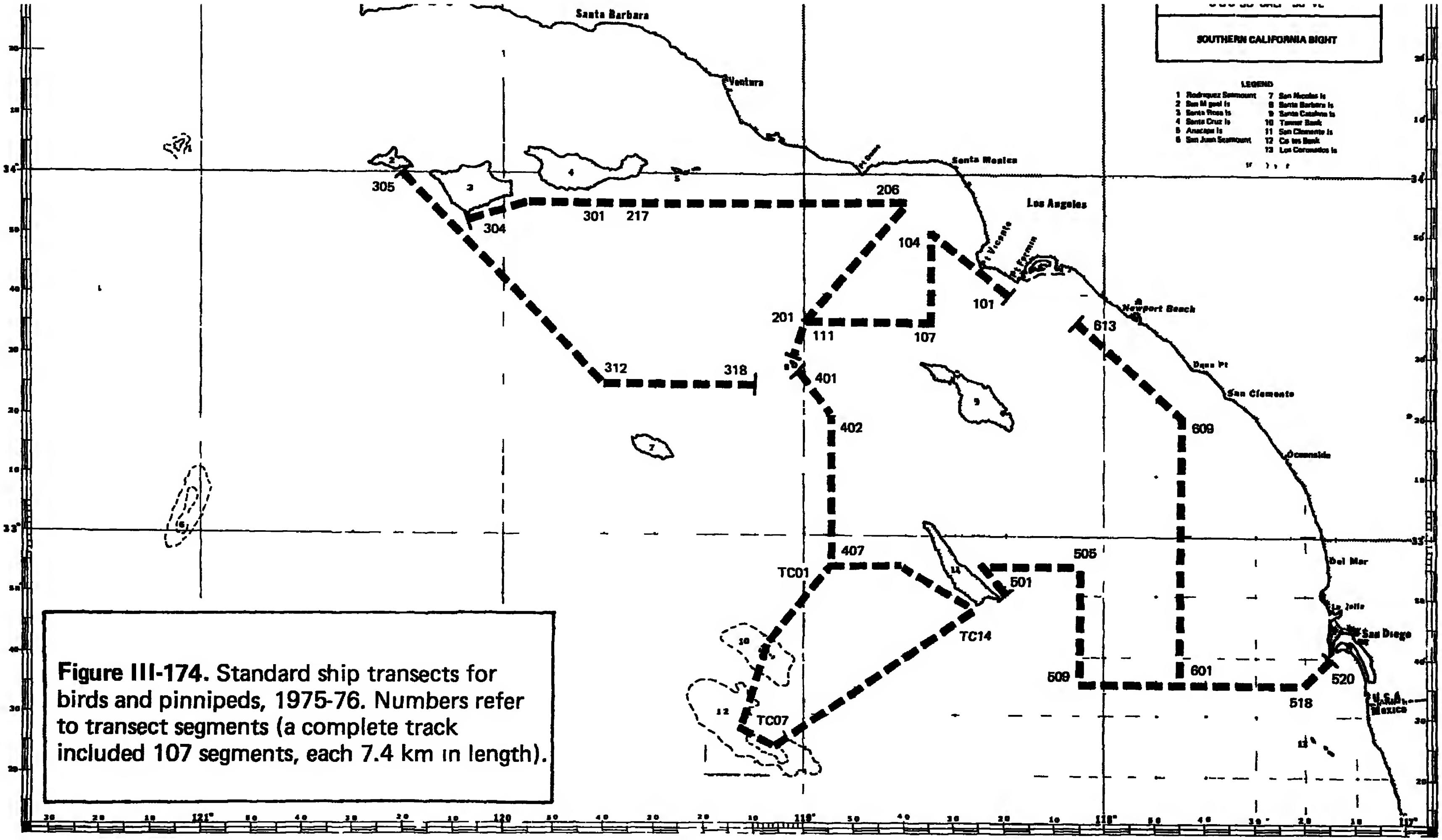

Figure III-174. Standard ship transects for birds and pinnipeds, 1975-76. Numbers refer to transect segments (a complete track included 107 segments, each 7.4 km in length).

Table III-112. Summary of dates and completeness of standard ship transects in May 1975 through February 1976. A complete cruise included 107 transect segments, each 7.4 km (4 NM) in length. Tanner-Cortés Banks (TC series) were not visited until trip 215.

Trip no.	Dates	Segments omitted
202	7-10 May 1975	all except 107-112, 202-04, 605-13
203	13-15 May	all except 214-304, 519-20
208	21-26 July	112, 519-20
211	25-30 August	519-20
215	22-27 September	101-109, TC13, 519-20
217	16-21 November	304-306, TC1 through 14
219	15-20 December	TC12-14, 501, 519-20
221	5-10 January 1976	301-304, 317-318, TC10-14
226	9-15 February	201-214, TC14, 520

The track was designed so that segments fell entirely within 10' lat-long blocs; most 10' blocs contained two segments. This arrangement allowed single observers to rest between segments. Observers were elevated 8 m ASL on standard transect cruises and between 3 m and 6 m on opportunistic tracks. Observers carried 7x, 8x or 10x hand-held binoculars.

All birds sighted on both sides of the ship were counted, identified, and observed for interspecific associations, feeding, and other aspects of behavior including response to the boat. Sighting distance from the boat was recorded as one of four categories: 0-50 m, 51-150 m, 151-400 m and beyond 400 m. Ranges were estimated with the aid of a split-image rangefinder, radar observations on nearby stationary targets, and the angle of inclination from the vertical.

Identifications and direct counts or estimates of numbers were made in the same manner as for aerial observations. The system employed was conservative with respect to specific identifications and all records on flock sizes included reliability estimates. Voucher specimens were not collected in 1975-76.

Field forms were used to record all shipboard observations (Fig. III-175),which were later transformed into 80 column computer records and entered into the permanent data bank.

Density and species composition were calculated for each 7.4 km segment and for each taxon. Since the maximum distance at which various seabirds may be reliably identified varies with plumage characteristics, body size and behavior, we initially chose a transect corridor width (800 m) that fell within the range at which most

species could be easily determined. We found, however, that this range was beyong the reliable sighting range for some smaller birds and we therefore used two different widths, 300 m and 800 m (150 and 400 m lateral distance to either side) for calculating seabird densities (Appendix III-A2).

We report density calculated from shipboard sampling by 10' blocs of latitude and longitude. In cases where two segments fall within a single 10' bloc, the density figures represent mean values for the two samples. The averaging process masks some variability between adjacent segments. Variance between adjacent segments in the same 10' bloc is greatest when banks, escarpments, or islands are nearby.

It should be emphasized that density figures generated by shipboard observations are to be considered relative rather than absolute for several reasons. First, the slow speed of the ship allows birds to react to its presence, thereby biasing density calculations through approach or avoidance. Second, the boat's forward movement necessarily renders all samples non-instantaneous. Third, since different species are detectable at different maximum ranges, correction factors are required to compare densities of different species at a given spot.

3. Reliability of methods

We carried out a series of field tests to evaluate the reliability of the air and ship survey methods employed. These tests included replications of counts over selected lines with various time delays between counts, additional census lines between existent

BIRDS SIGHTING LOG

DATE 8 Jan 16 OBSERVER Lewis

SEGMENT NUMBER TC-09

TIME START 1632 TIME STOP 1654

SHIP Ken & Daisy CRUISE 2 21

COURSE/SPEED 42/10 °mag/kn

SURFACE TEMP. 22°C FOREL #

SEA STATE 3 (BEAUFORT)

FATIGUE 2 HEIGHT 20 ft

WIND DIR/SPEED 315/8 kn

AIR TEMP 14 °C VISIBILITY 10 km

CLOUD COVER (10th's) 1 (4)

BARO PRESS 1013 mb TREND

Cu. sea 1

TIME	SPECIES: NUMBER/RANGE												REMARKS
start 1632		FN	2cc	KIB	Gull	GOLL	PHAL	AKC	SPC				
1632		2/III											1(270) Dark
1636			4/III	4/III	3/III								1
1639						10/III							1,2
1640				1A/III	1A/III								1(045)
1641		1/III											1(315)
1642							1/II						1(180)
1642				3/III									1(338)
1643								3/III					1(135)
1644				2/I									1(270)
1644						150/III							1 w/Delph
	200-300 Delphinus leaping, chasing etc @ 400 m D												
	1-2 Dall po ?? w/ Delphinus												
1645				1A/II									1(180)
1646				1A/F					2/I				1 SPC·KIB
1645									2/II				2
1650		1/I											1(045)
1652		1/II											1(270)
1653									1/III				1(180)
1654	End Segment												

Figure III-175. Sample of bird sighting log.

one to several km are less similar (higher Coefficient of Variation) than replicate counts of a single line, but between-line variation is not great. Some of this between-line variation is probably a result of differences in distance from land, bottom physiography, and other environmental features that influence bird distribution and abundance. Variations of counts made on two adjacent ship's segments within the same 10' bloc of latitude and longitude are of the same order as variance between replicates of a given line. Thus it is justified to average counts within a given 10' bloc when presenting density figures from shipboard observations.

C) Estimates of species composition are quite similar when counts are separated by less than six hours and involve either replicates of one line, or adjacent lines separated by one to five km (and not including sections near an island or mainland beach). These results apply to both surface and air counts.

D) On two occasions in which ship and plane counts were made over the same waters at the same time, density figures generated from surface data were lower than those from air data by a factor of 2 to 4. Ship density figures were higher (somewhat closer to air figures) when only sightings between 0 and 150 m from the vessel (a 300 m corridor width) were considered, rather than all sightings out to 400 m (an 800 m corridor). In one of these comparisons, variance between replicate ship counts was lower than that between replicate air counts on the same 18.5 km transect (6 counts by ship, 4 by air in a 4-hour period); the Coefficient of Variation for ship counts, V ship, was 13.9%

ones to estimate the scope of geographical variation in density and composition, and simultaneous counts from airplane and ship in the same waters to compare the two censusing techniques. The results of these tests are discussed below, and analyzed in greater detail in Appendix III-A2. We found that:

A) When density figures derived from two to six counts on a given line are compared, the variance between counts within a two- to three-hour span is of the same order of magnitude as the mean of the counts. Values of Pearson's Coefficient of Variation ($V = \frac{s}{\bar{x}} \cdot 100$) range from 7.5% to approximately 70%, averaging 14% for ship counts and 48% for aerial. When the time span between replications increases, variance (and Coefficient of Variation) increases. Counts made 6 to 24 hours apart show values of V from 30 to 100%. Counts made more than 24 hours apart are often quite dissimilar. On the other hand, we found that bird density in major geographical sectors (Cortés Bank, for example) was relatively high or low for several months at a time. These results apply equally to ship and air counts.

B) Comparison of counts made on lines separated by one to ten km and within two hours' span gave similar density-of-sightings figures, though less so than replicate counts over a single line. Coefficients of Variation calculated in such comparisons range from 10% to 141%, averaging 40%. This is true of both ship and air counts. These results can be restated as follows: density calculations from two parallel lines separated by

while V air was 47.7%. The difference between V ship and V air probably related to the much narrower transect corridor of aerial counts. When species composition from the two sources (ship and air) were compared, we found that the percentage of small birds (small alcids, phalaropes) seen from the surface was considerably smaller than from the air (9.4% compared to 24% of all sightings), and the percentage of gulls seen from the ship was correspondingly higher. As expected, the relative proportion of less precise, generic or familial identifications to specific identifications was higher in aircraft than in ship counts.

These differences in density of sightings and in proportion of relatively inconspicuous targets (small, dark birds that often rest on the surface and dive to avoid the ship) are suggestive of greater accuracy in estimating bird density from the air than from the surface. Hence, throughout this report we present avian density as derived from aerial counts when making interspecific and seasonal comparisons. We present ship density figures when comparing the relative abundance of a given species from one area to the next. Ship data are also used to refine determinations of species composition derived from air observations, where ship and air operations coincided in space and time.

4. Nearshore surveys

a. Aerial observations

We surveyed the perimeter of each of the Channel Islands from

the air upon intersecting an island during open-ocean transect runs. For example, we generally flew around San Nicolas Is. when we reached the point where transect line 119°30'W intersected the island. Interruptions of transect continuity due to circum-island work probably had little effect on at-sea density calculations and were very beneficial in relieving fatigue. The dates and geographical locations of aerial visits to islands are given in Table III-113.

We flew clockwise around islands, as dictated by the configuration of our aircraft. Flight speeds averaged 180 km/hr, and altitudes varied from 100 to 150 m ASL. Observers recorded all bird sightings on voice tapes that were later transcribed and edited. Virtually all aggregations of birds of greater than 25 individuals were photographed with 80-200 mm or 300 mm lenses on motor-driven Nikon 35 mm cameras. Photographic logs and entries on voice tapes keyed the photos to specific geographical features of the coastline.

Photographs were processed and mounted as slides. The number of photographs from each flight series (6 to 8 islands) varied from 500 to 1250 frames. Voice tapes of visual sightings were matched with aerial photographs, and the best estimates of numbers and species composition were entered into the computer.

b. Inshore ship surveys

Whenever possible, we surveyed the birds found within the kelp zone around the Channel Islands. Birds within 200-500 m of shore were counted, including those seen on the immediate shoreline. We kept the boat just outside the main kelp beds at a constant speed between 11 and 15 km/hr and counted everything between the boat and shore. Few birds actually in or flying over the water were likely

Table III-113. Aerial survey coverage of birds on the islands of the Southern California Bight, May 1975 - March 1976. Abbreviations: c = complete circuit of island; p = partial circuit of island; ph = photographic coverage; v = visual coverage. Dash indicates not surveyed.

Island	Flight number and dates							
	101 16-17 May	102 27-30 June	103 4-7 Aug	106 23-26 Oct	108 16-18 Dec	109 6 Jan	110 22-25 Jan	112 12-14 Mar
San Miguel	p-ph	p-ph+v	c-ph+v	c-ph+v	-	c-ph+v	c-ph+v	c-ph+v
Santa Rosa	p-ph	c-ph+v	c-v	c-ph+v	-	-	c-ph+v	c-ph+v
Santa Cruz	p-ph	c-ph+v	c-ph+v	c-ph+v	-	-	c-ph+v	c-ph+v
Anacapa	p-ph	c-ph+v	p-ph+v	-	-	-	-	-
San Nicolas	p-ph	c-ph+v	p-ph+v	c-ph+v	-	c-ph+v	c-ph+v	c-ph+v
Santa Barbara	c-ph	c-ph+v	c-ph+v	c-ph+v	p-ph+v	-	c-ph+v	c-ph+v
Santa Catalina	c-ph+v	c-ph+v	c-ph+v	c-ph+v	p-ph+v	-	c-ph+v	c-ph+v
San Clemente	c-ph+v	c-ph+v	p-ph+v	p-ph+v	p-ph+v	-	p-ph+v	c-ph+v

to be overlooked; however, many shorebirds, especially those of rocky shorelines, were undoubtedly overlooked because of their small size and cryptic coloration.

Table III-114 shows the schedule of inshore ship surveys in 1975-76. Surveys of this sort were conducted primarily around the four northern islands and Santa Barbara Is. and included cruises in spring and summer 1975, and winter 1976.

c. Beach studies

We censused birds from shore monthly from April 1975 through March 1976. Beaches censused for live birds were the same as those surveyed for dead ones (Figs. III-176 and 177).

All live birds on the beaches and up to 400 m out to sea were counted with the aid of binoculars. The birds were identified and tallied, noting sex and age-class, location relative to the beach, plumage characters, and species associations when possible.

Several factors affect the collection of data by this method. Since our censuses were done while moving along the beach itself, we tended to push the birds ahead of us, thus creating the probability of recounts. Although allowances were always made for recounting, some error can be assumed in most cases, especially where shorebird aggregations were present. In addition, censuses were made at different times of the day in different months, and since it simply took longer to survey certain beaches, counts of species such as pelicans, terns and gulls, tended to be inflated. Finally, complete surveys of all the beaches were not made until July, with the addition of the beaches at Pt. Mugu. May and June surveys included all beaches except P.M.T.C., Pt. Mugu, and the April survey omitted Dockweiler and

Table III- 114. Schedule of inshore ship surveys, 1975 - 76.

Trip no.	Dates	Island
2-03	13-15 May, 1975	San Miguel (all).
2-06	16-20 June, 1975	Santa Rosa (south), Santa Cruz (south), Anacapa (south), Santa Barbara (all).
2-07	14-18 July, 1975	Santa Rosa (north), Santa Cruz (north), Anacapa (south), San Clemente (all).
2-24	14-18 Jan., 1976	San Miguel (all), Santa Rosa (north and southwest), Santa Cruz (north-east), Anacapa (all), Santa Barbara (all).
2-27	11-14 Feb., 1976	San Miguel (all), Santa Rosa (south-east), Santa Cruz (south), Anacapa (all), Santa Catalina (all).
2-32	16-22 Mar., 1976	Prince, Santa Rosa (southeast), Santa Cruz (south), Anacapa (north), Santa Barbara (all).

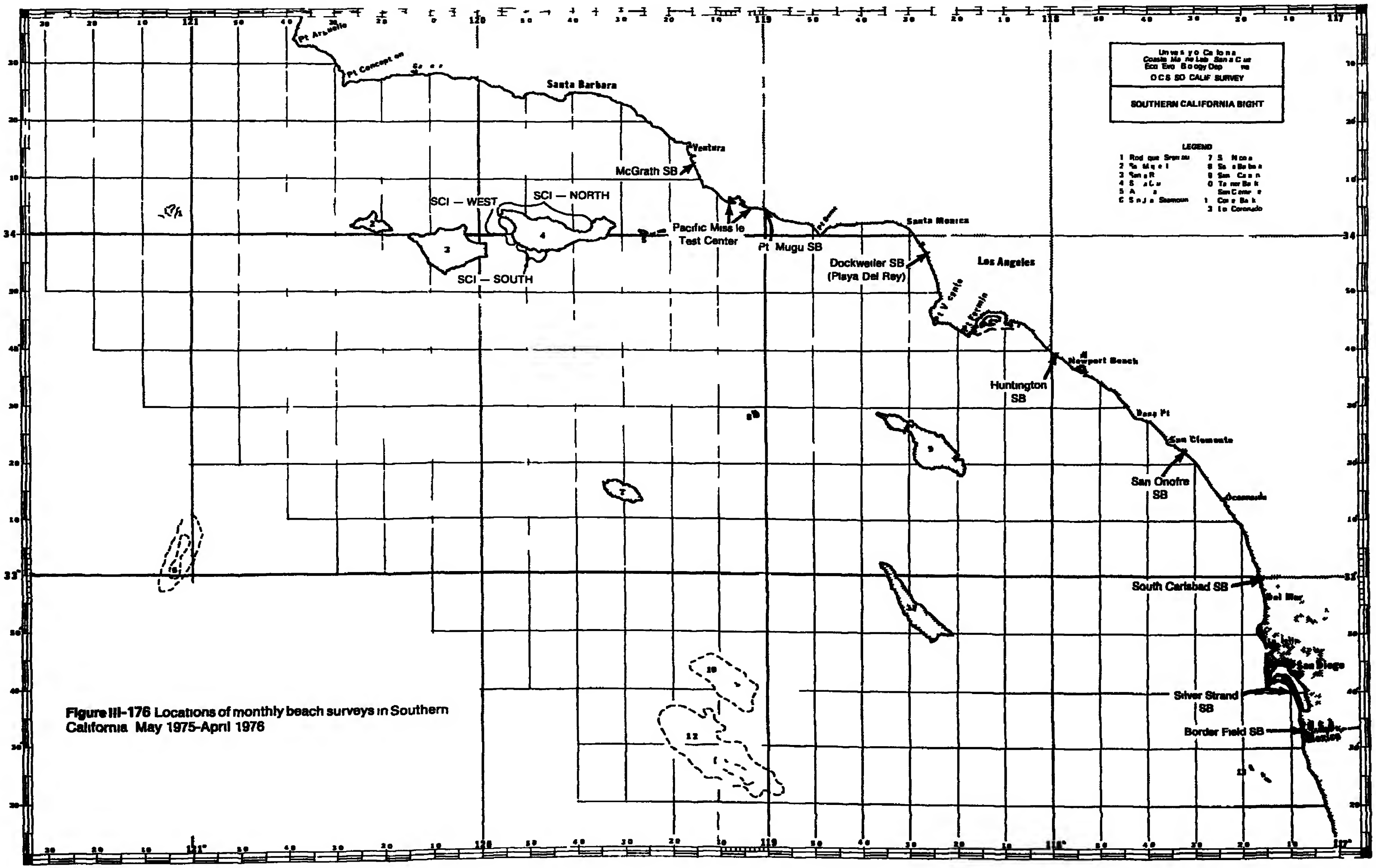

Figure III-176 Locations of monthly beach surveys in Southern California May 1975-April 1976

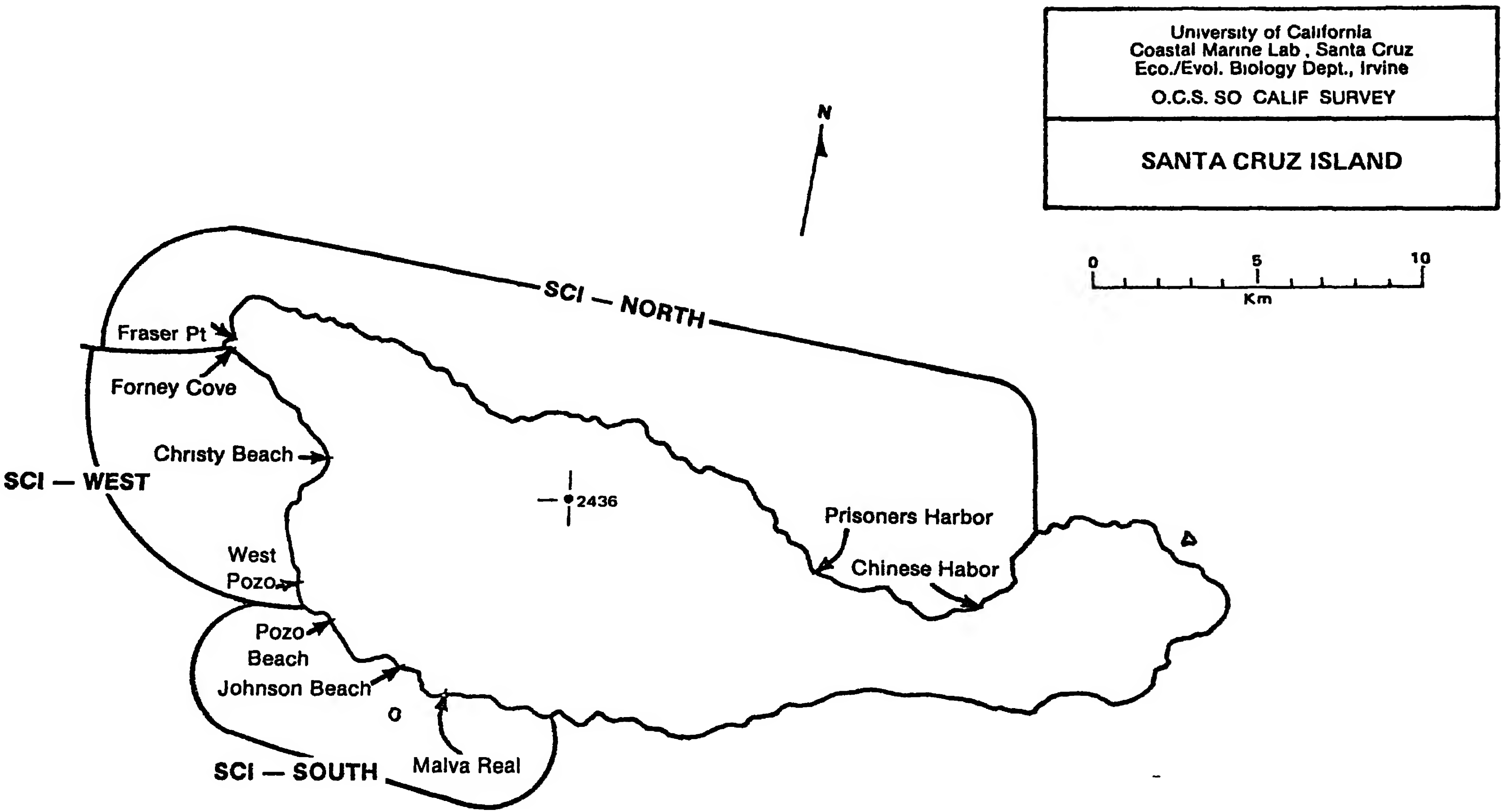

Figure III-177.. Locations of monthly beach surveys on Santa Cruz Island. May 1975-April 1976.

Huntington State Beaches as well. We present beach counts as indices of composition and abundance for circumscribed sections of coast.

d. Comparison of methods

Aerial surveys around islands complemented the relative strengths and deficiencies of the shipboard and terrestrial techniques. Airborne observers were able to take both perspective-type and close-up photographs of large roosts on land and of aggregations in the kelp. This was not often possible for observers on foot or on ship. Airborne observers covered the islands in a few days whereas observers on a ship required more than a week to do so. On the other hand, observations from ship and land were more detailed and were more precise with respect to species identification. Airborne observers generally concentrated on the immediate shoreline, coastal ledges and cliffs, and the zone between the kelp and the beach. Shipboard counts emphasized the kelp zone, while terrestrial observers provided great detail about the beaches. In short, we used one technique that was rapid and broad, and two others that were of more limited geographic and temporal scope, but yielded more detail.

We were not able to conduct simultaneous counts to establish conversion factors for the different inshore and littoral techniques. Accordingly, data from these sources represent gross indices of the relative abundance and composition of the nearshore fauna, not "hard" estimates of density except in cases in which aerial photographs are available. These data are presented as raw numbers of birds observed per circumscribed section of coastline. Figures III-178 through III-185 show place names and numerical codes for islands discussed in the text.

III-506

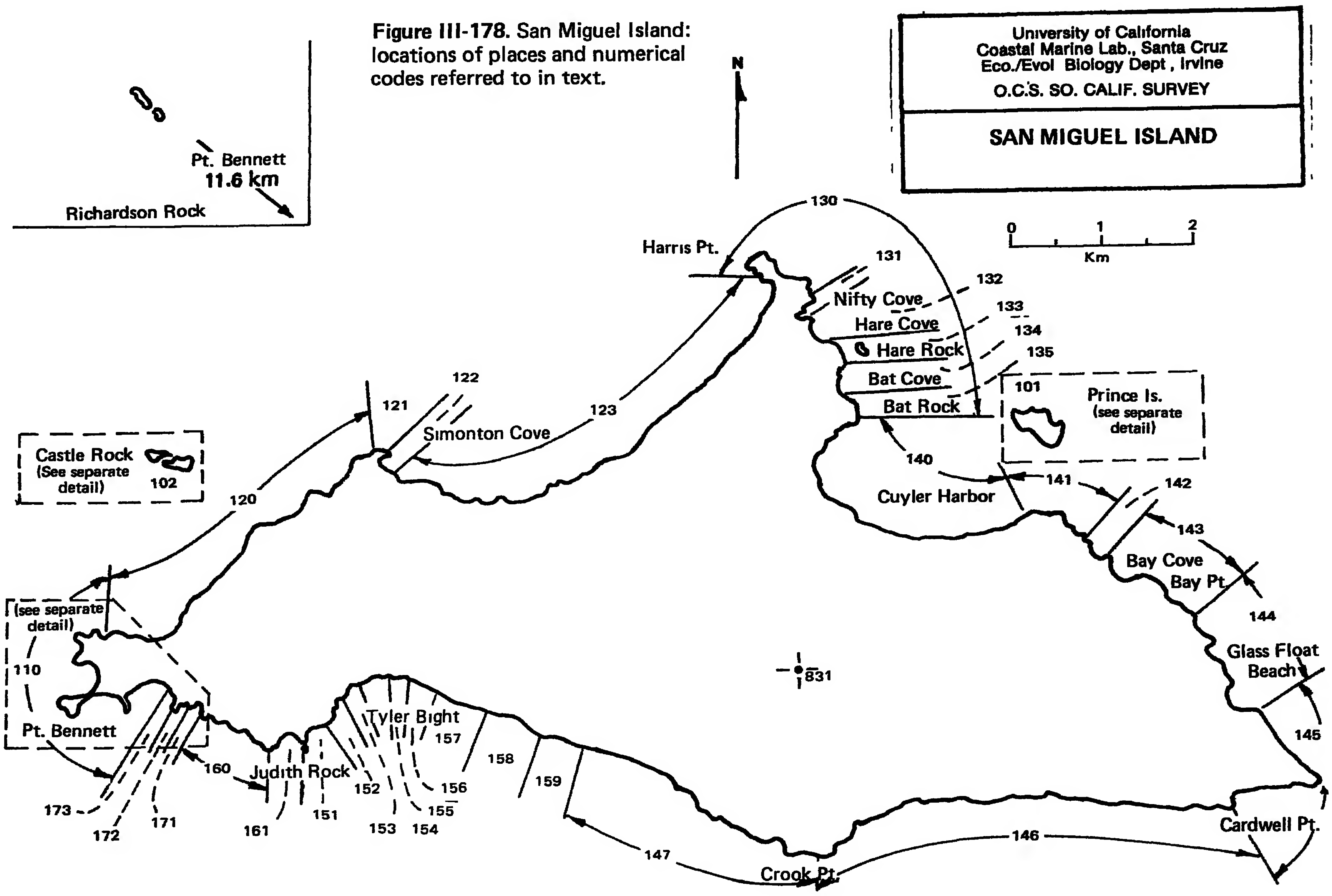

Figure III-178. San Miguel Island: locations of places and numerical codes referred to in text.

III-507

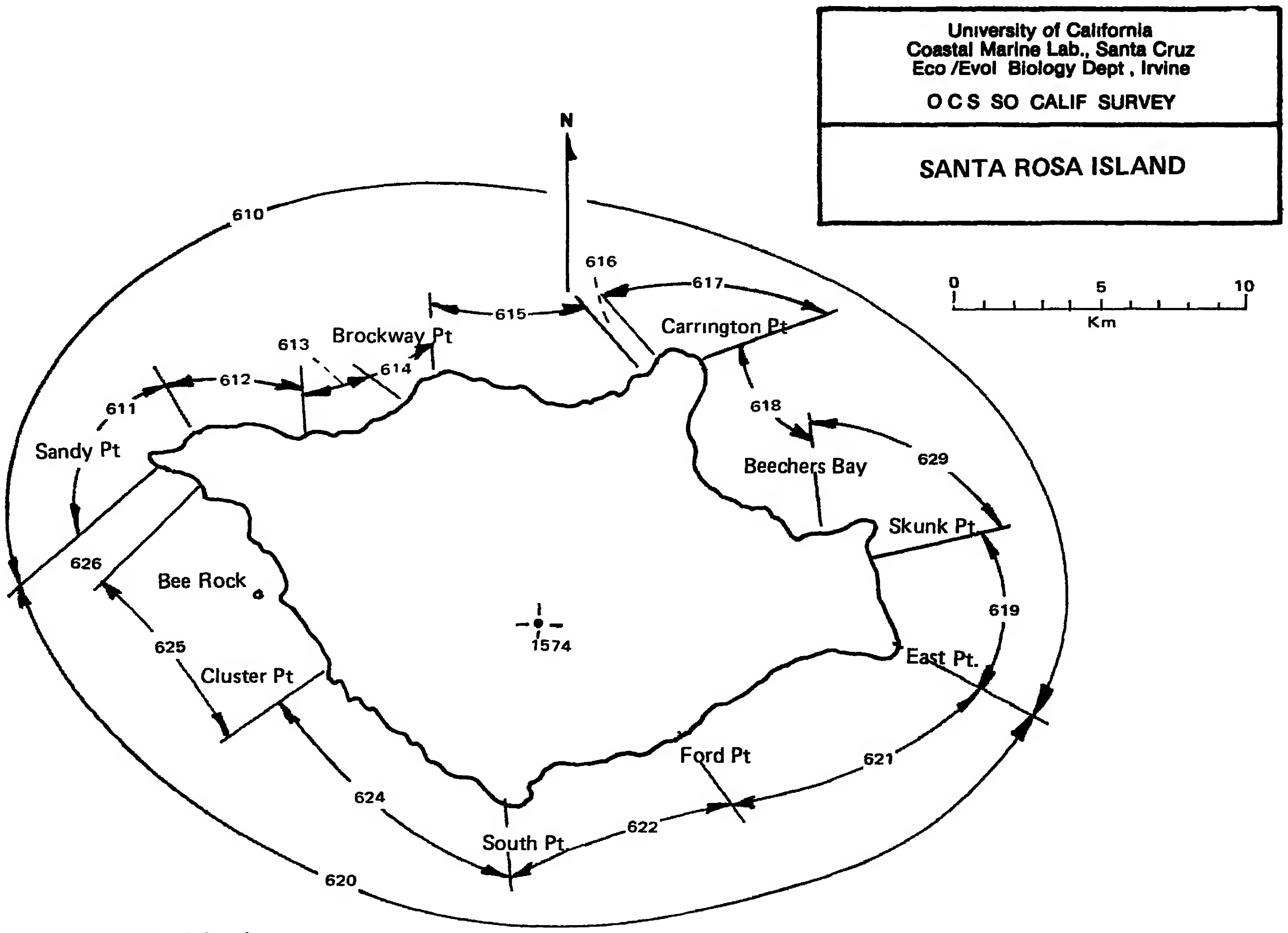

Figure III-179. Santa Rosa Island: locations of places and numerical codes referred to in text.

III-508

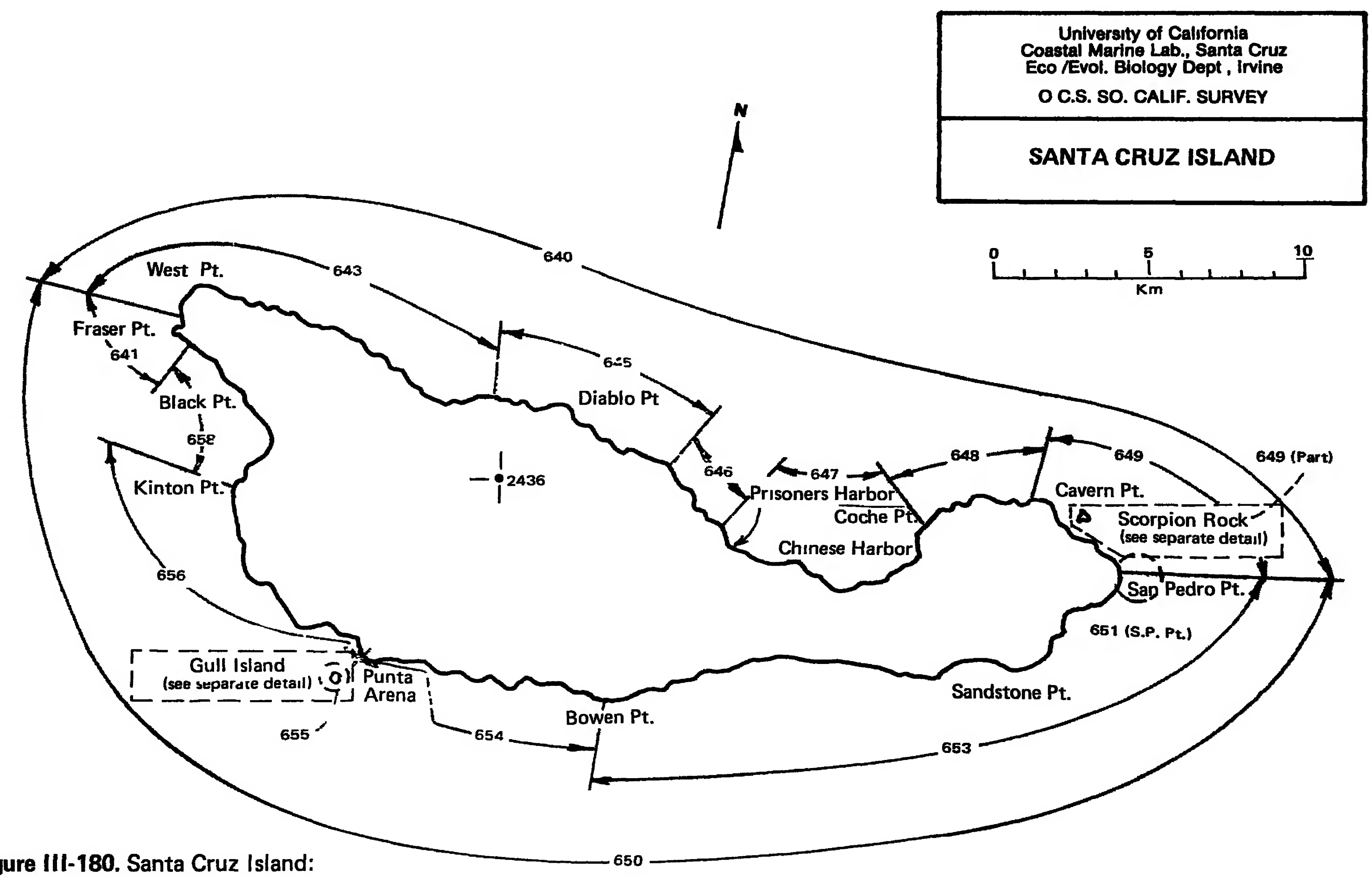

Figure III-180. Santa Cruz Island: locations of places and numerical codes referred to in text.

III-509

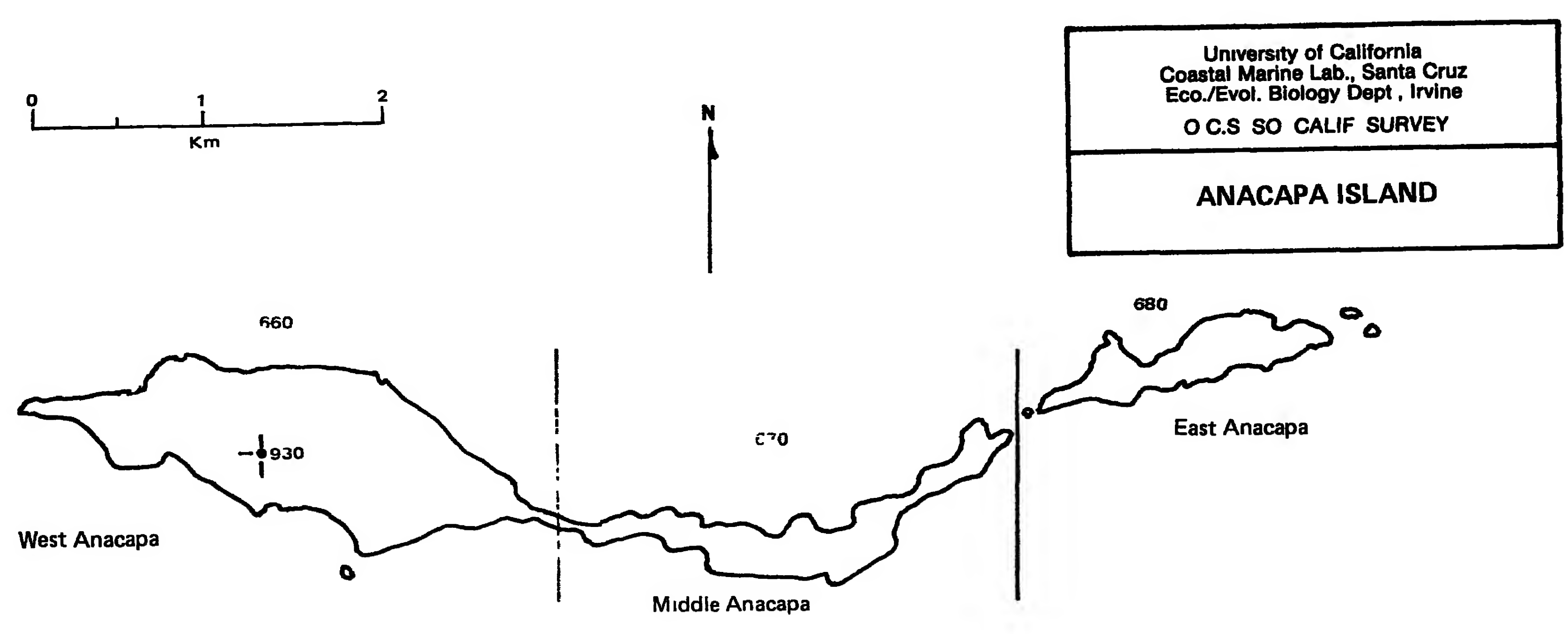

Figure III-181. Anacapa Island: locations of places and numerical codes referred to in text.

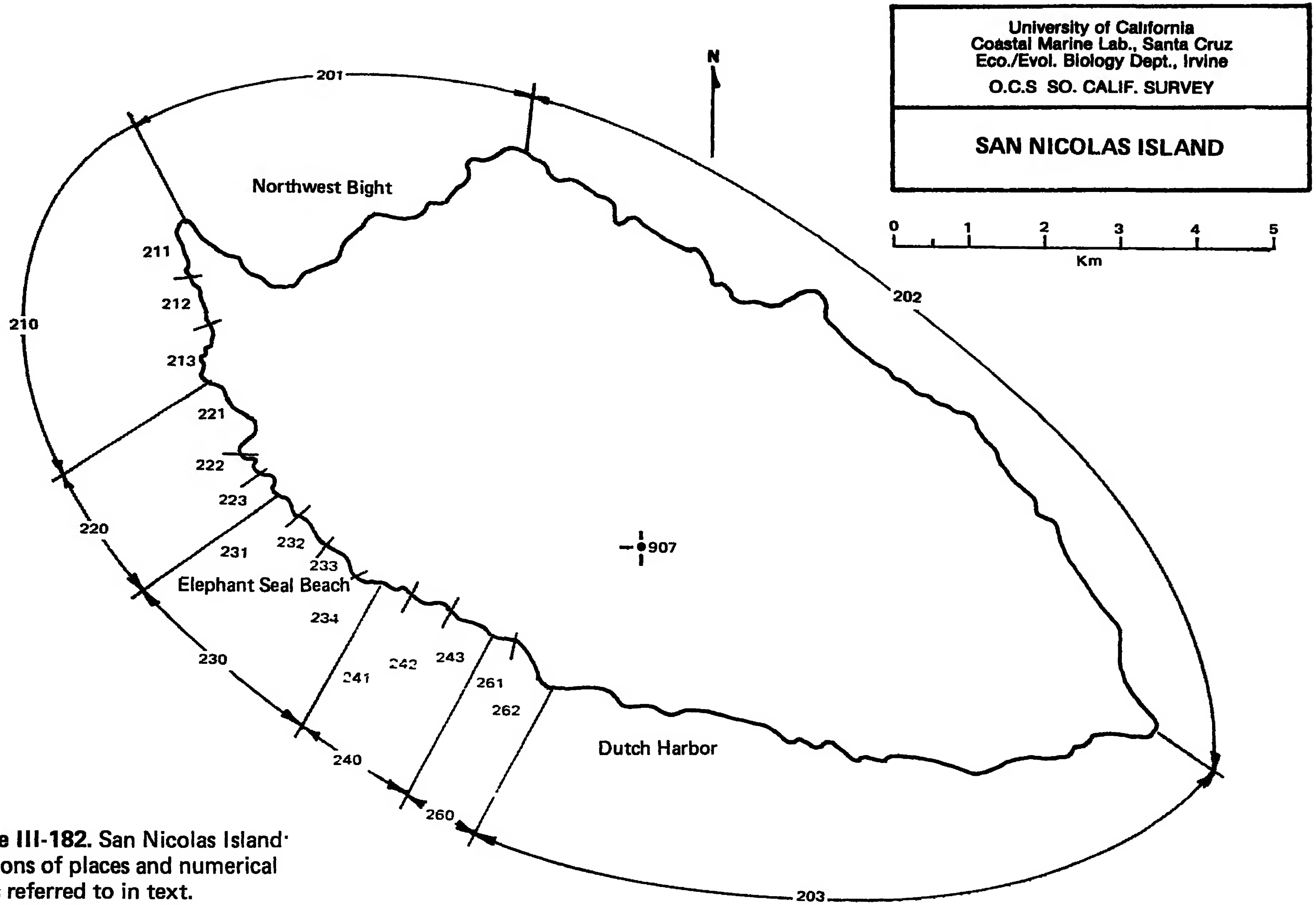

Figure III-182. San Nicolas Island· locations of places and numerical codes referred to in text.

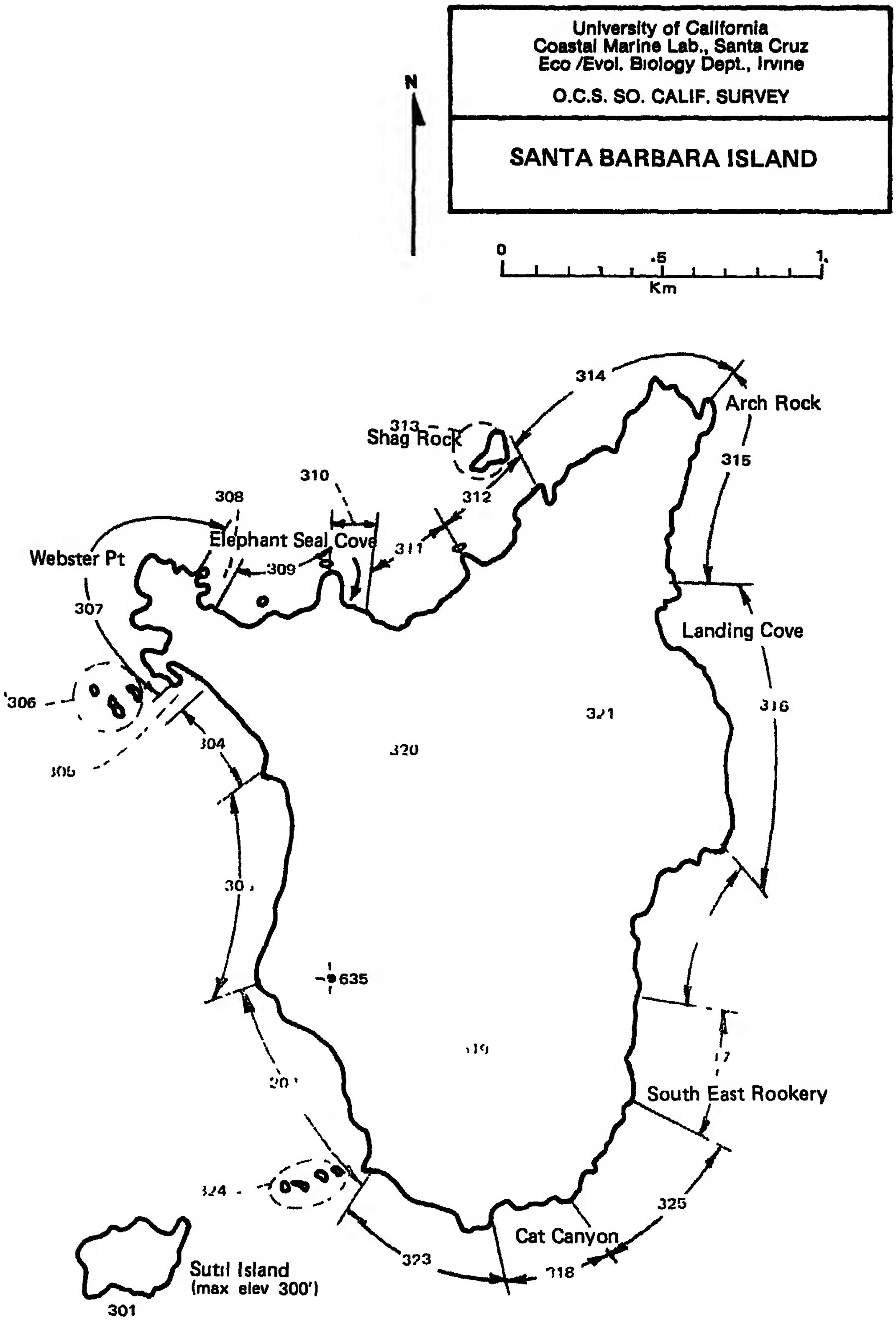

Figure III-183. Santa Barbara Island: locations of places and numerical codes referred to in text.

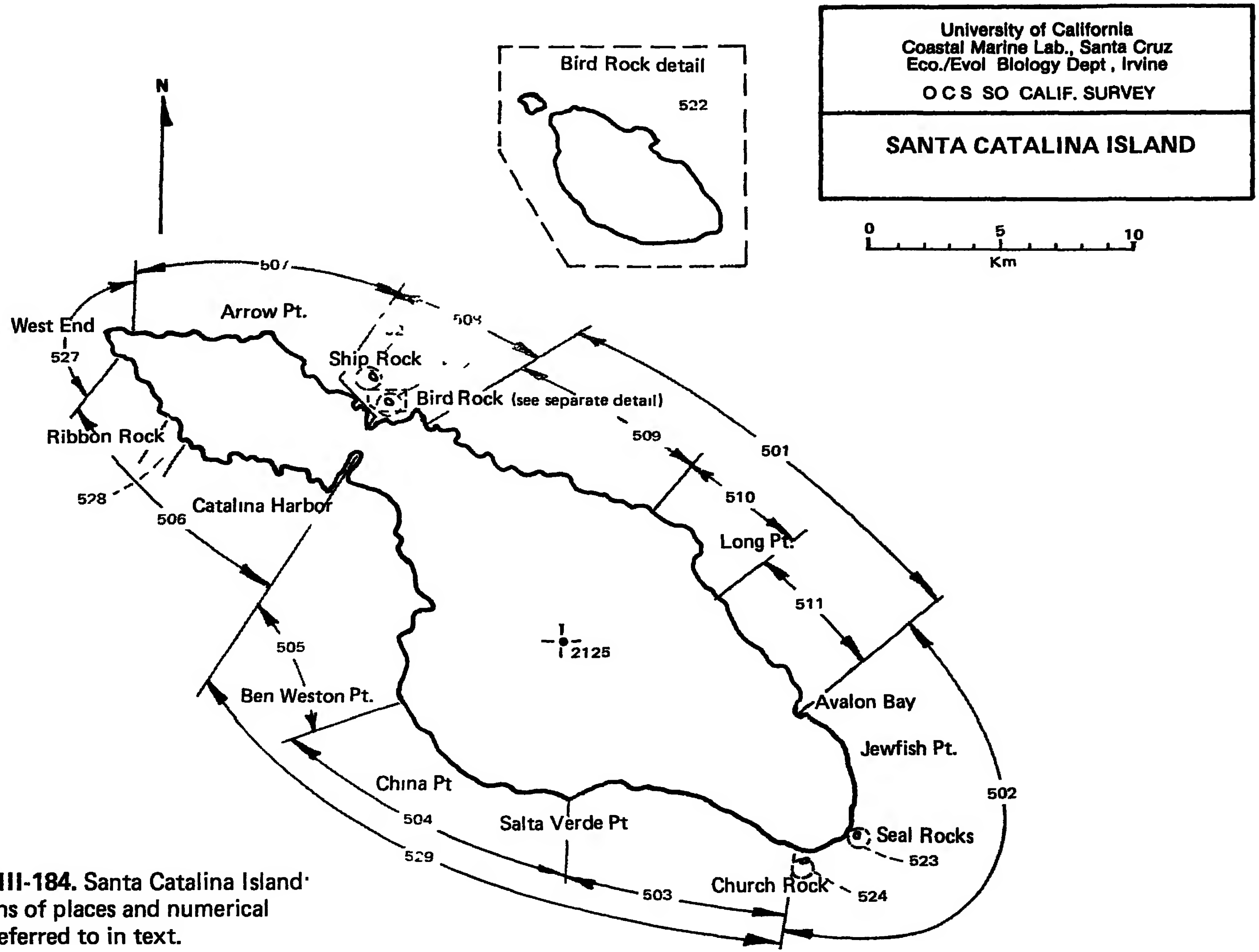

Figure III-184. Santa Catalina Island· locations of places and numerical codes referred to in text.

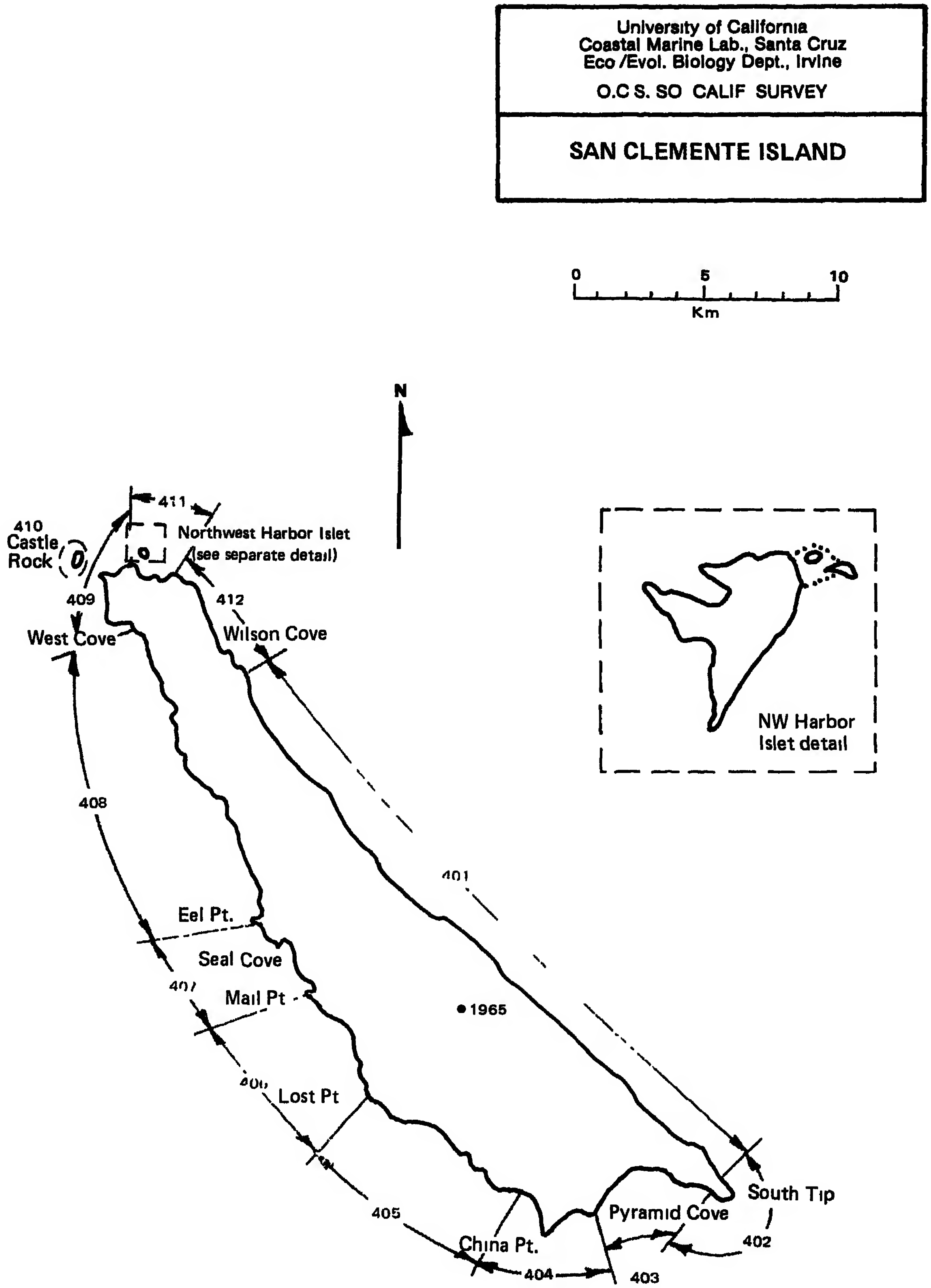

Figure III-185. San Clemente Island: locations of places and numerical codes referred to in text.

C. Results

1. Seabird colonies

The results of our 1975 colony censuses are presented in Table III-115. All breeding colonies located in 1975 are discussed below by island or island group. Historical breeding data are discussed briefly below and in detail in Appendix III-A3.

a. San Miguel Island (including Prince Island, Castle Rock and Richardson Rock)

The largest and most diverse seabird colony in southern California is located here (Figs. III-186-187), mainly on Prince Is. There is a large colony on Castle Rk. and several colonies of Pelagic Cormorants and Pigeon Guillemots along the north shore of San Miguel Is. At present eight species of seabirds nest here though historically eleven species have nested.

1975 data (see Fig. III-187). Five Ashy Storm-Petrels (species determination made by measurements of wing chord and tarsus) came aboard our boat at Prince Is. after dark on 13 May, and others (approximately 20) were heard calling as they came into the island for the evening. On 14 May D. Lewis located a probable active nest site by odor on the southeastern slope of Prince Is. We did not attempt to document breeding on nearby Castle Rk.

We estimated 20 to 40 breeding pairs of Double-crested Cormorants on Prince Is. but were unable to obtain an actual nest count without disturbing the birds. We counted 860 active nests of Brandt's Cormorants on Prince Is., 216 on Castle Rk. and 42 on Pt. Bennett for a total of 1,118 nests at San Miguel Is. Approximately 48 active nests of Pelagic Cormorants were counted by us at four localities

Table III-115. Numbers of seabird pairs nesting on the California Channel Islands in 1975. Species abbreviations are as in Table III-110

Symbols: - = not present; ? = possibly present, but not found; + = present, but no estimate of numbers obtained.

	Island	Species								
		PTAS	PELB	COD	COB	COP	GUW	GP	MLX	AKC
1.	San Miguel Is.	?	-	-	42	31	+	140	?	?
	Castle Rk.	?	-	-	216	15	+	40	?	+
	Prince Is.	+	-	20-40	860	1	600	200	+	10,000
	Richardson Rk.	?	-	-	-	-	?	-	-	?
2.	Santa Rosa Is.	?	-	-	200	+	+	+	?	?
3.	Santa Cruz Is.	?	-	-	?	?	?	+	?	?
	Gull Is.	?	-	-	23	4	31	-	?	30
	Scorpion Rk.	?	80 *	-	?	-	50	1	?	?
4.	West Anacapa Is.	?	212 *	+	1	1	+	?	?	?
4.	Middle Anacapa Is.	?	-	-	-	-	1000-	-	?	?
4.	East Anacapa Is.	?	-	-	-	-	3000	-	?	?
5.	San Nicolas Is.	?	-	-	365	-	720	-	?	?
6.	Santa Barbara Is.	?	-	2	27	1	1162	60	ca.1000	?
	Sutil Is.	?	-	8	93	-	?	20	?	?
	Shag Rk.	?	-	-	-	-	?	?	?	?
7.	Santa Catalina Is.	?	-	-	-	-	?	-	?	?
	Bird Rk.	?	-	-	-	-	25-30	-	?	-
	Ship Rk.	?	-	-	-	-	-	-	?	-
8.	San Clemente Is.	?	-	-	12	-	?	-	?	?
	Castle Rk.	?	-	-	1	-	?	-	?	?
	Bird Rk. (NW Harbor)	-	-	-	-	-	31	-	-	-

* Anderson, et al, 1976

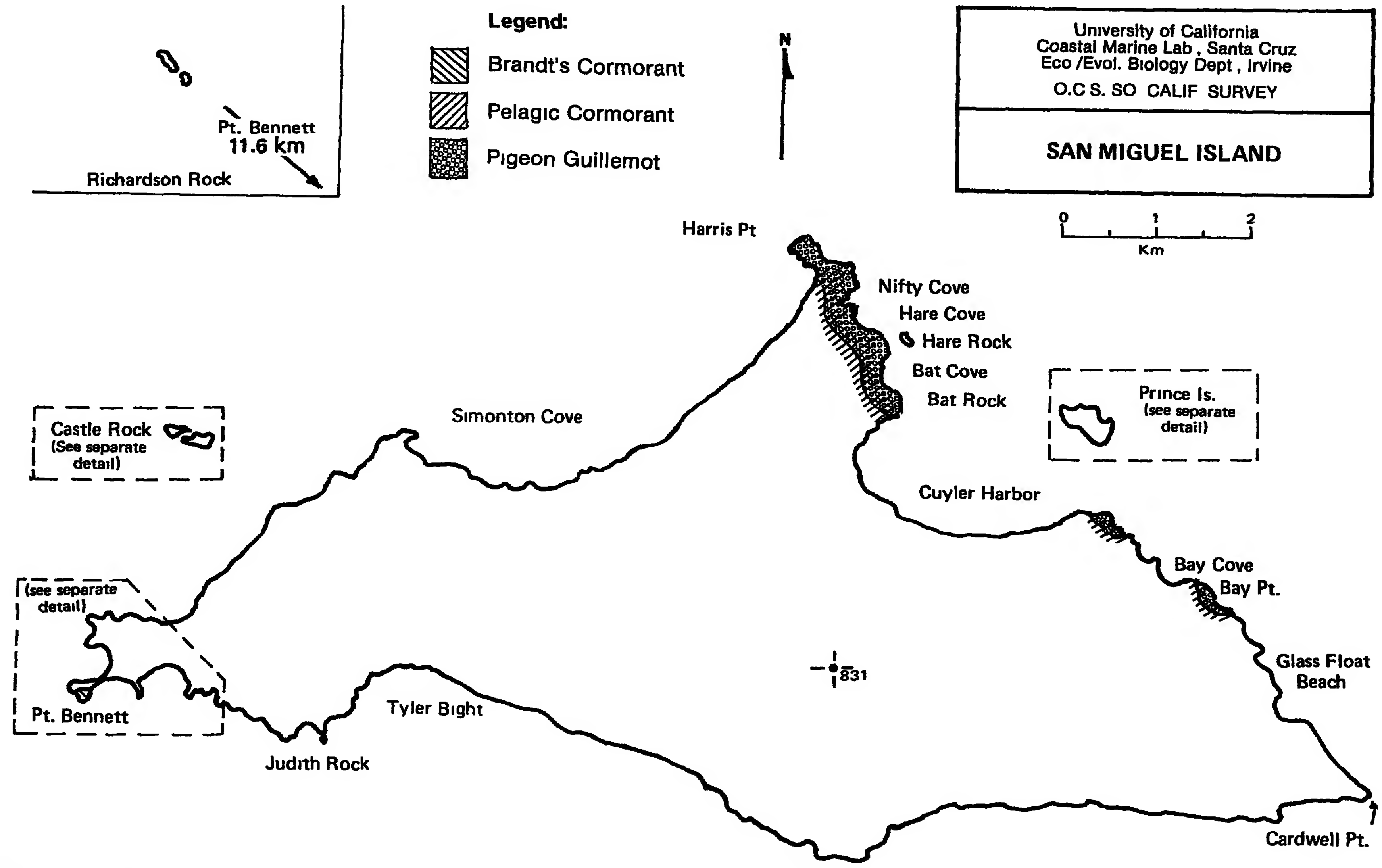

Figure III-186. Distribution of nesting colonies on San Miguel Island.

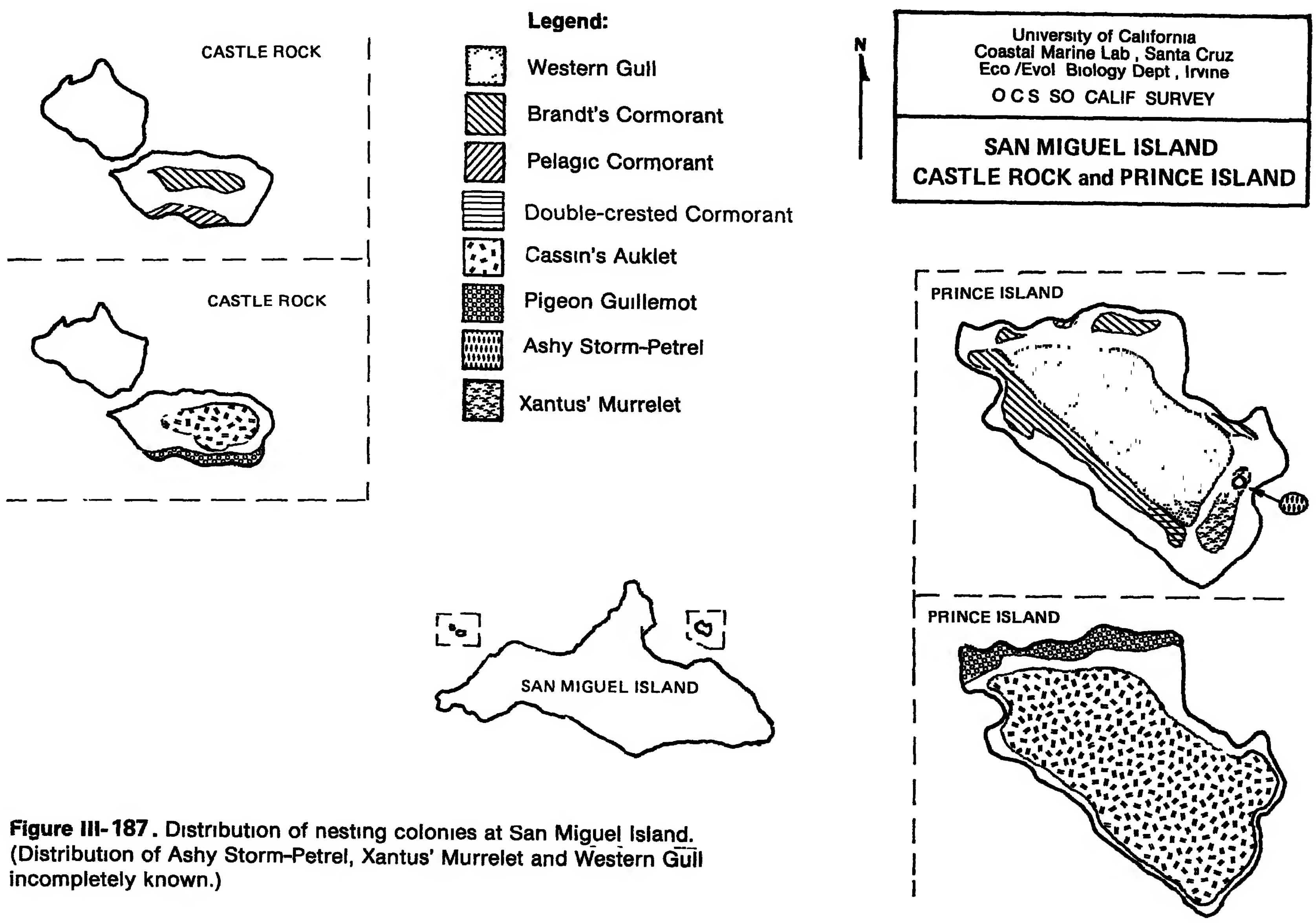

Figure III-187. Distribution of nesting colonies at San Miguel Island. (Distribution of Ashy Storm-Petrel, Xantus' Murrelet and Western Gull incompletely known.)

on San Miguel Is. on 14 May as follows: 1 on Prince Is., 15 on Castle Rk., 14-18 at the east end of Cuyler Harbor and 16 at Bat Rk.

Approximately 600 pairs of Western Gulls nested on Prince Is. in 1975. A few others undoubtedly nest on Castle Rk. and scattered localities on the main island of San Miguel as well. Our estimate for Prince Is. was based on counts of territorial birds on the slopes and an actual count of 200 nests with eggs on the flat area at the top of the island.

By the method outlined on p. III-484 we estimated 200 nesting pairs of Pigeon Guillemots on Prince Is., 40 at Castle Rk., and 140 pairs breeding at three or more localities on the main island of San Miguel for a total of 380 breeding pairs on the island complex.

On Prince Is. we found one active Xantus' Murrelet nest and several inactive nest sites on 13 May and 5 birds came aboard our boat at Prince Is. that evening. We also heard approximately 25 birds flying around the island on the same evening. Most of the murrelets there are suspected of nesting in the dense and mostly inaccessible _Opuntia_/sage-scrub thicket on the southeastern slope.

We found major colonies of Cassin's Auklets on Prince Is. and Castle Rk. We were not able to land on Castle Rk. but could see numerous burrows on the east and northeast side. On Prince Is. we estimated a minimum of 9,600 pairs to be breeding based on our quadrat method outlined on p. III-482. We found 40 active burrows in one 625 m^2 quadrat in typical ice plant (_Gasoul crystallinum_) habitat on top of Prince Is. and an average of 1.2 active burrows (range 0-9) in each of thirty,25 m^2 quadrats in typical rocky

hillside habitat with little or no vegetation. Our nest density estimates were, thus, 6.4 nests/100 m^2 in the ice plant and 4.8 nests/100 m^2 on the rocky slopes of the island. The total auklet breeding area on Prince Is. was estimated to be 200,000 m^2, thus giving us an estimated total number of 9,600 to 12,800 auklet pairs on the island. Since some of the unoccupied (= inactive) burrows may have been occupied earlier in the year, the actual number of auklets breeding here in 1975 may have been even higher.

b. Santa Rosa Island

Very little is known about the seabirds on this island since it has rarely been visited by ornithologists in the past, and much of the northern coastline is not readily accessible by boat because of large kelp beds, reefs and frequent rough seas on this side.

1975 data (see Fig. III-188): A colony of Brandt's Cormorants with a minimum of 200 active nests was located by plane at Carrington Pt. A few scattered groups may also nest on the cliffs between Carrington and Brockway Pts. and in Beecher Bay but these areas were not checked thoroughly. No Pelagic Cormorant nests were found at Santa Rosa Is., but many birds were present and probably breeding on the sea cliffs between Brockway and Carrington Pts., an area almost completely inaccessible with a large boat.

No accurate counts of Pigeon Guillemots were obtained for Santa Rosa Is. but they breed along the northern shore from at least Brockway Pt. to near Skunk Pt. Our 1975 counts at Santa Rosa Is. are certainly under-representative of the actual breeding population here. We saw five between East Pt., and Ford Pt. on 18 April and 10 between Carrington Pt. and Sandy Pt. on 14 July.

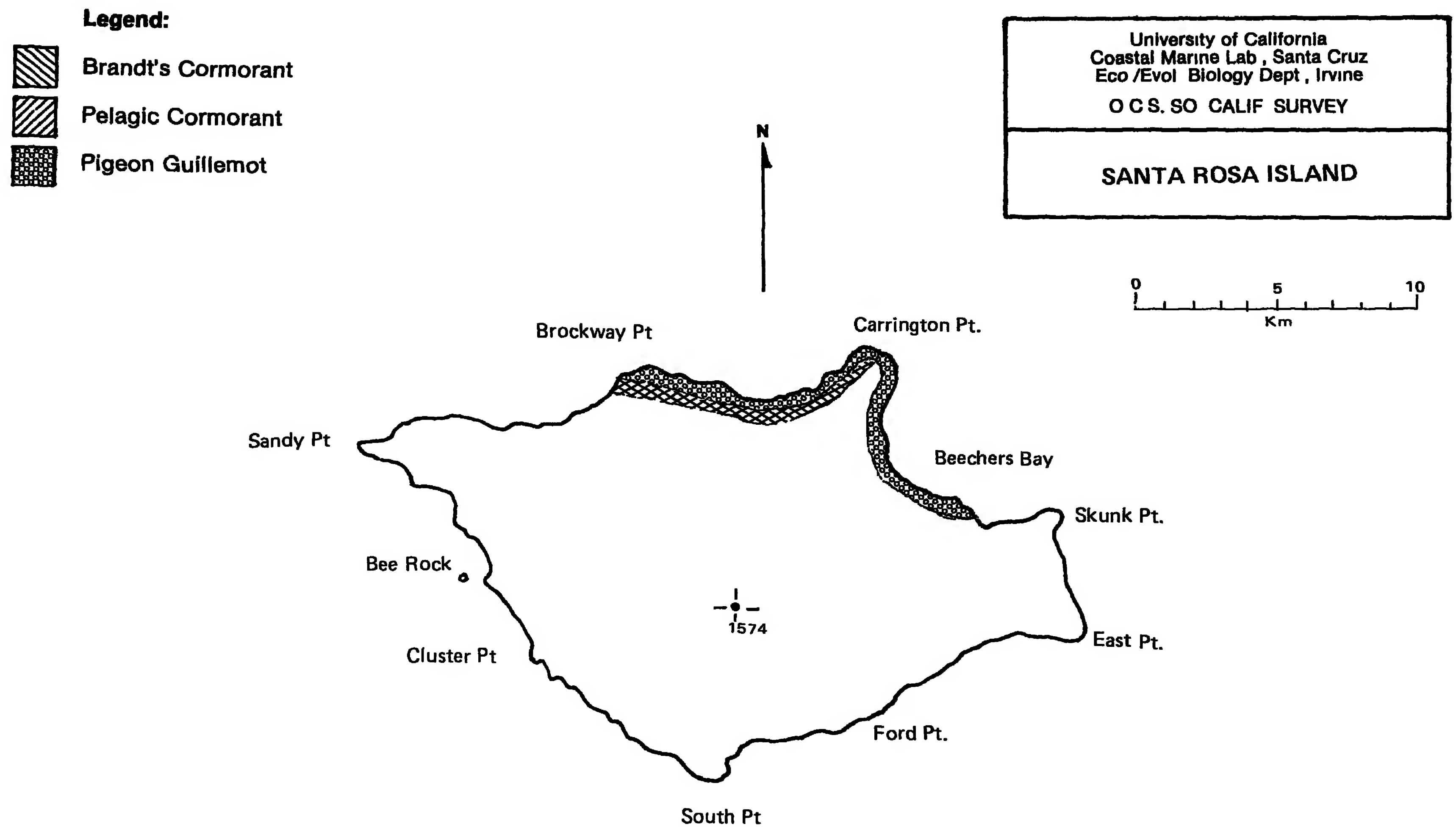

Figure III-188. Distribution of nesting colonies on Santa Rosa Island. (Distribution of Brandt's Cormorant and Pigeon Guillemot incompletely known.)

c. Santa Cruz Island (including Gull Island and Scorpion Rock)

As on the other large islands, seabirds are primarily confined to the offshore islets and precipitous coastal cliffs where they are safe from terrestrial predators.

1975 data (see Fig. III-189): We checked Painted Cave on 14 July for Ashy Storm-Petrels, but were unable to determine whether or not they were present. It is suggested that future investigators spend a night at anchor there and at Scorpion Rk. in May, June or July and listen for storm-petrels.

Brown Pelicans bred on Scorpion Rk. in 1975, producing 74 young from 80 nests (Anderson et al. in press).

Cormorant nests located at Santa Cruz Is. included 23 Brandt's and 4 Pelagic on Gull Is. on 18 April. There were at least 20 cormorant nests in the vicinity of Fraser Pt. as well.

We counted 31 Western Gull nest scrapes on Gull Is. on 18 April and estimated that approximately 50 pairs had nested on Scorpion Rk. in 1975 based on chick counts made 14 July. On 14 July we counted 310 Pigeon Guillemots between San Pedro Pt. and Fraser Pt., the great majority being seen between Painted Caves and Fraser Pt. Four juveniles, the first of the season, were seen on the water between Scorpion Rk. and Painted Caves on this date.

On Gull Is. we counted 69 Cassin's Auklet burrows on 18 April, of which 30 were considered to be active. We also found an old auklet burrow on Scorpion Rk.

d. Anacapa Island

Historically this island has been an important seabird breeding

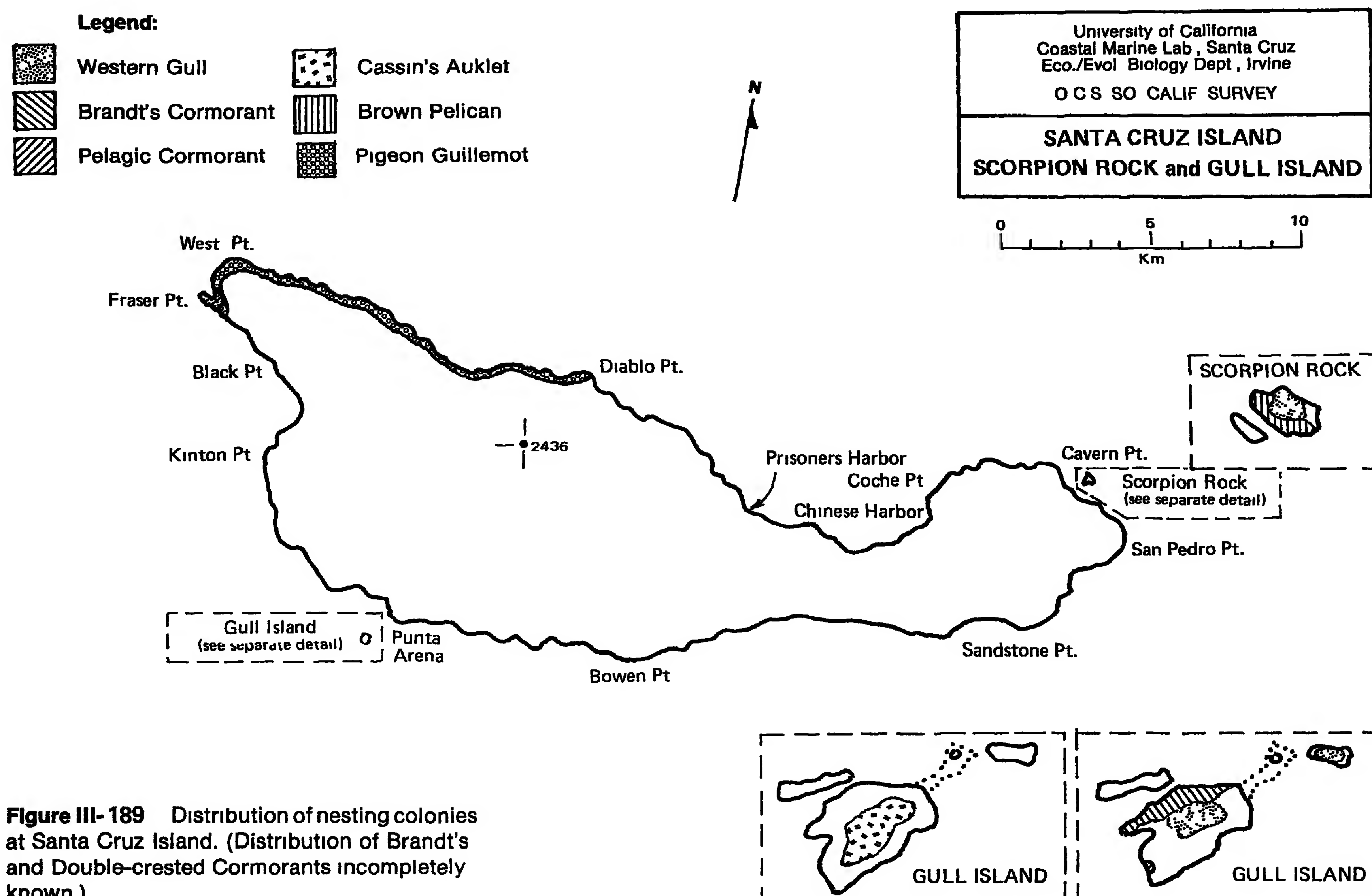

Figure III-189 Distribution of nesting colonies at Santa Cruz Island. (Distribution of Brandt's and Double-crested Cormorants incompletely known.)

locality and today is the principal California nesting locality of the endangered Brown Pelican.

1975 data (see Fig. III-190): We made no attempts to estimate breeding numbers of Brown Pelicans on Anacapa, but did observe birds on nests on West Anacapa Is. Anderson et al. (in press) observed 212 active nests that fledged 182 young.

We observed at least 2 Double-crested Cormorant nests from our boat on West Is. on 16 June, and there were probably other nests that we could not see. We could find only one certain Brandt's Cormorant nest at Anacapa, this on West Is., though again a few nests may have been overlooked since we could not land on West Is. An apparently active Pelagic Cormorant nest with two adults attending was also observed on West Is. on 16 June and 14 July.

We obtained no firm estimate of the number of breeding Western Gulls on Anacapa, though we made a "guestimate" of 1,000 to 3,000 pairs based on counts of territorial birds observed from our boat and from counts made onshore on Middle and East Islands.

Pigeon Guillemots may not have bred at Anacapa Is. in 1975, although 8 adults were seen at West Anacapa Is. on 14 July. None were seen here on other visits in April, May and June, however.

One Xantus' Murrelet was heard at East Is. on the night of 3 May by Kimball Garrett, but we have no other evidence which may suggest breeding in 1975.

e. San Nicolas Island

This island has Western Gulls and Brandt's Cormorants breeding, and there is a possibility but no satisfactory evidence that several other seabird species may formerly have bred here.

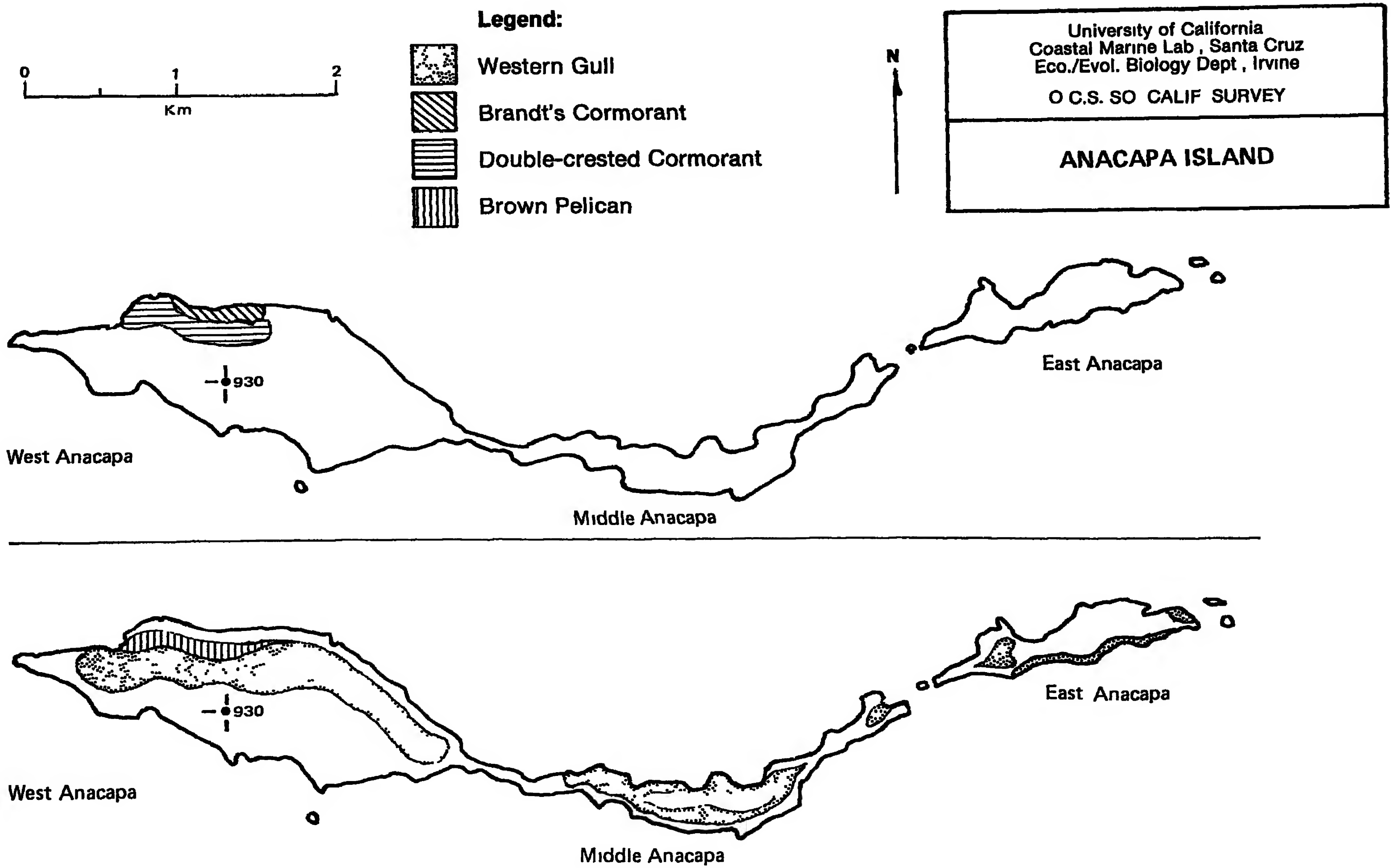

Figure III- 190. Distribution of nesting colonies on Anacapa Island. (Distribution of Brandt's Cormorant incompletely known.)

1975 data (see Fig. III-191): We counted 52 active nests of Brandt's Cormorants at the west end of San Nicolas Is. on 20 April; however, on 11 June all but 18 of these nests had been abandoned and 115 fresh, but unfinished nests were counted in another area about 150 m away. On 19 June 2 additional active nests were found 1.5 km away and the 115 partial nests had been abandoned, thus a total of 20 active nests were located. An additional colony was located and photographed by plane in May and June. It was located 1 km east-southeast of the westernmost point of the island and contained approximately 230-265 active nests. This colony was not visited by land or boat and its fate was thus not determined.

The Western Gull colony at the west end of the island contained approximately 720 nesting pairs in 1975. We obtained this estimate by walking 100 meter transects through the colony and counting all active nests within 3 meters to either side to obtain nest density per unit area (Fig. III-192). We walked 13 transects across the width of the colony on 11 June. These transects varied from 80 to 170 meters in length because of the variable width of the colony. The colony was 1600 m in length and transects were taken at the 50, 150, 250, 350, 500, 600, 700, 800, 900, 1000, 1200, 1400 and 1500 meter marks, with the starting point (0 meters) taken as the southeast end of the colony. We obtained an average density of 0.41 nests per 100 m^2 with transects at 350, 800, 900 and 1000 m having no active nests at all and the one at 1500 m having 10 nests. We estimated the total colony area to be 176,000 m^2, thus an estimated 720 active nests in the colony. If all nests including empty ones are counted, then the estimated number is 0.58 nests/100 m^2 or 1020 nests total. The

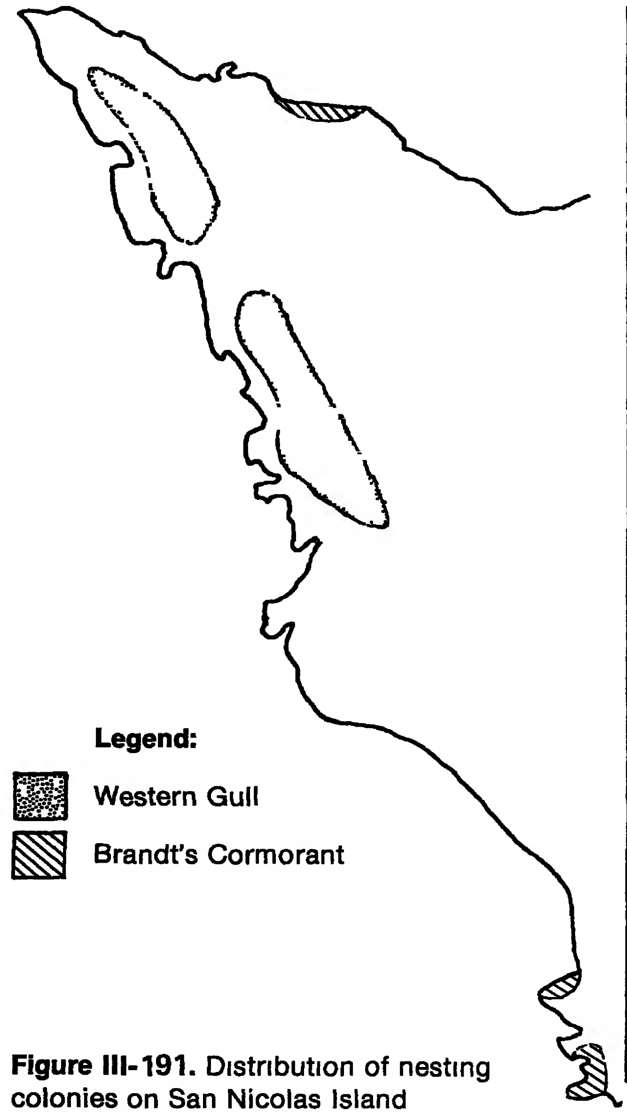

Figure III-191. Distribution of nesting colonies on San Nicolas Island

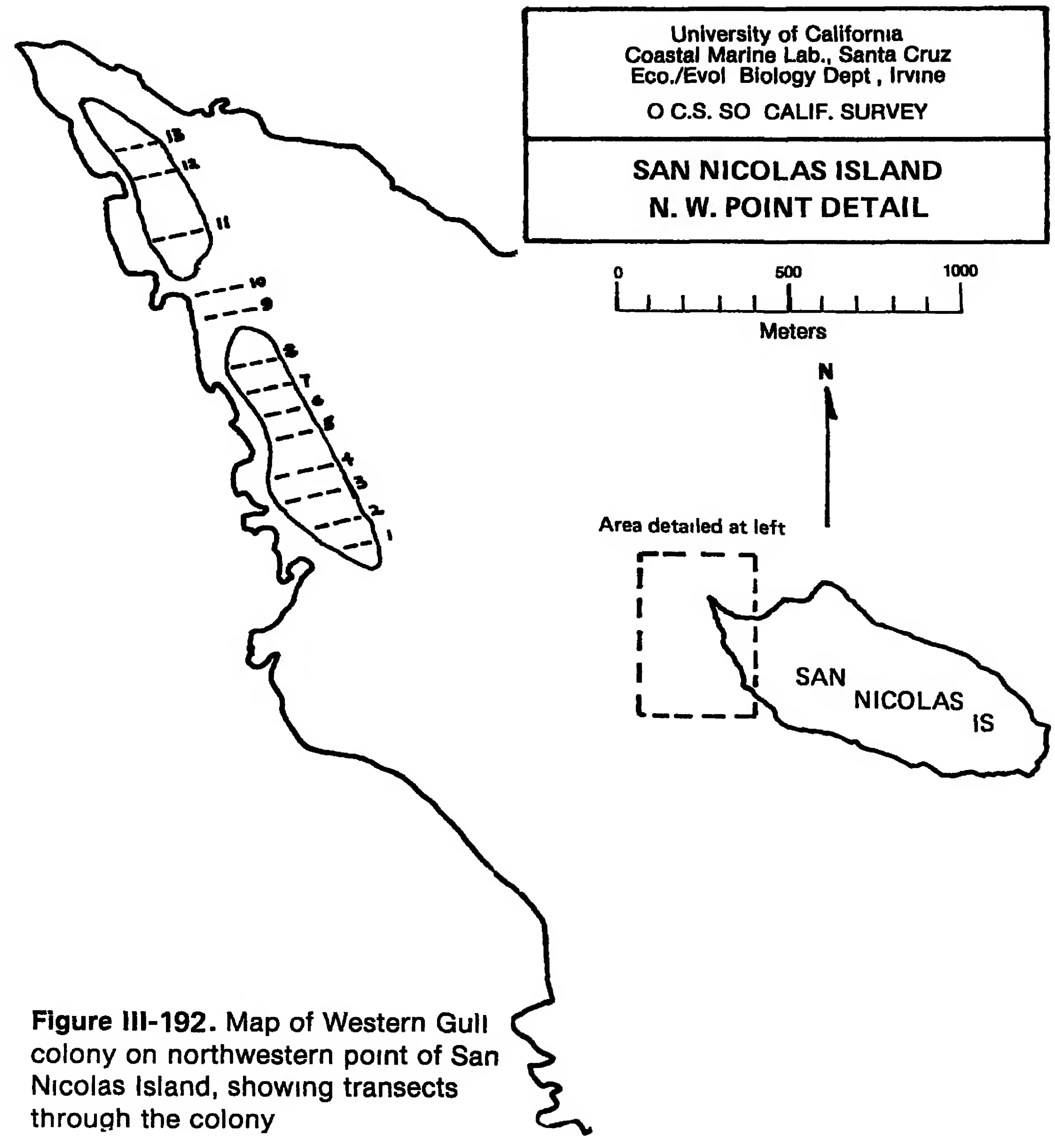

Figure III-192. Map of Western Gull colony on northwestern point of San Nicolas Island, showing transects through the colony

latter figure is probably less realistic since gulls frequently build several nests prior to selecting one for egg-laying.

f. Santa Barbara Island (including Sutil Island and Shag Rock)

This island, San Miguel (chiefly Prince Is.), and Anacapa Is., are the three largest and most diverse seabird colonies in southern California.

1975 data (see Fig. III-193): We found 10 active Double-crested Cormorant nests at Santa Barbara Is. on 20 June: 8 on Sutil Rk. and 2 on the north side of the main island across from Shag Rk. There were also 3 inactive nests at the latter locality. We found 120 active nests of Brandt's Cormorant: 93 on Sutil Is. and 27 on the north shore of the main island. We also found one attended and apparently active Pelagic Cormorant nest site on the north coast of the main island on 20 June and 16 July.

We estimated 1162 breeding pairs of Western Gulls here based on several independent counts of territorial birds. The largest group was on the low, flat western mesa.

There is a large colony of Xantus' Murrelets on the island and a preliminary estimate from our 1975 censuses indicates about 1,000 breeding pairs were present. Fifty-eight nests were found along the eastern shore in April and May, primarily under low growing shrubs such as Eriophyllum nevinii and Lycium californicum. We counted nests in 9 transects of 100 x 4 m and in 2 quadrats in prime murrelet habitat to obtain density/unit area estimates. Five transects had no nests, 2 had 1 nest each, 1 had 5 nests and 1 had 6 nests. The average nest density was 0.36 nests/100 m^2. The

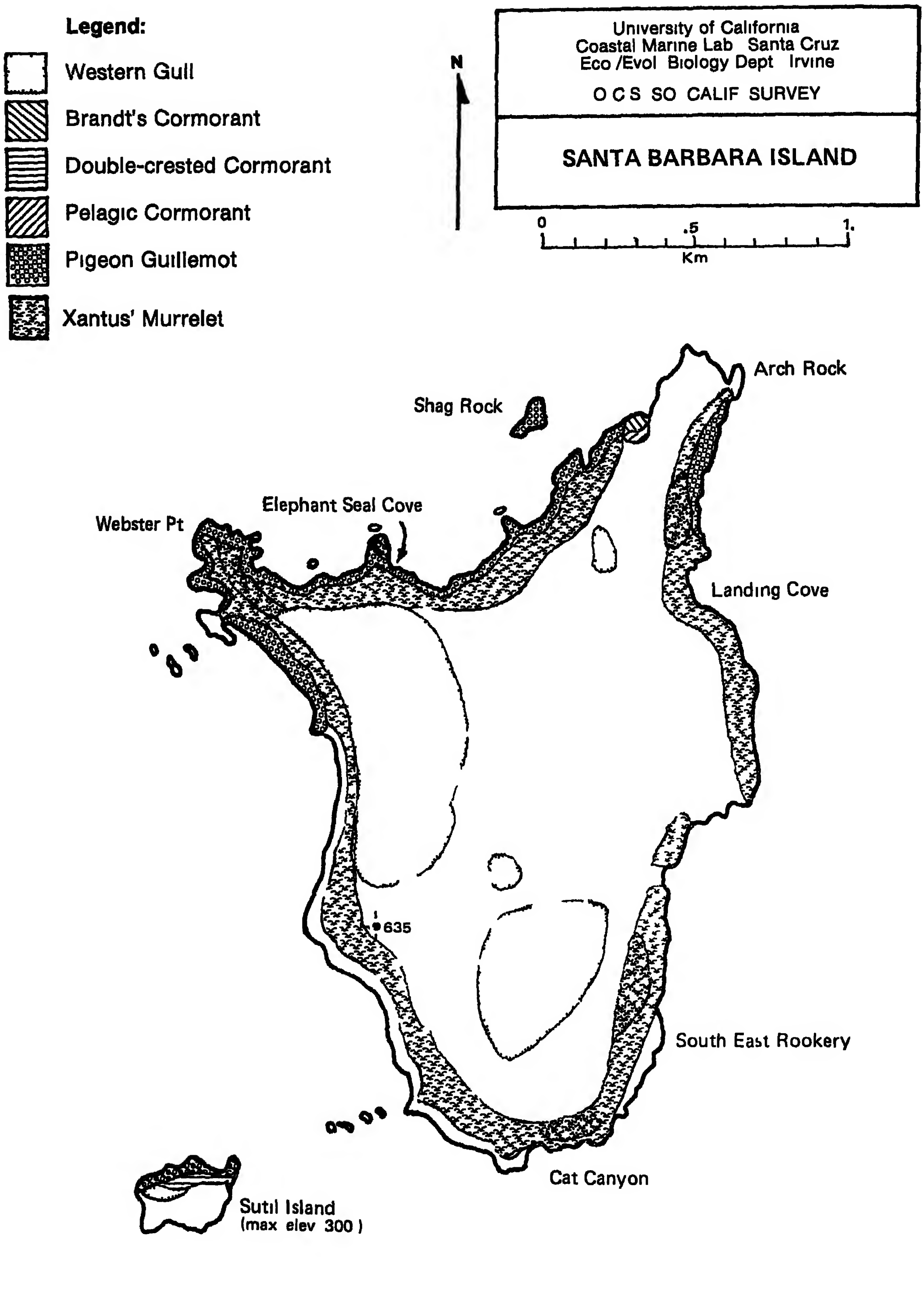

Figure III-193. Distribution of nesting colonies at Santa Barbara Island

two quadrats were 107 m^2 and 704 m^2 and contained 12 and 6 nests, respectively for an average nest density of 2.2 nests/100 m^2. Total murrelet habitat on the island is probably in the neighborhood of 500,000 m^2. Since the total area of suitable nesting habitat on the island is very poorly known at present and since the areas where density/area estimates were made were areas of known high density, any attempts to extrapolate to total population size at this point would be premature. Our feeling is that there were about 1,000 pairs breeding in 1975 based primarily on numbers of birds heard at night around the island and the total number of nests located.

We estimated about 60 breeding pairs of Pigeon Guillemots on Santa Barbara Is. and 20 additional pairs on Sutil Rk. based on our counts of 90 birds on the water off the north end of the island on 20 June and 30 birds seen near Sutil Rk. on 18 April (see p. III-484 for how these estimates were made).

g. Santa Catalina Island (including Bird Rock and Ship Rock)

This island has no major seabird colonies. In fact, the only colonies present have been restricted to two small rocks off Isthmus Cove.

1975 data (see Fig. III-194): The only species we found breeding in 1975 was Western Gull. We counted 50 chicks and 7 nests with eggs on Bird Rk. on 20 June and estimated that 25 to 30 pairs of gulls had bred there in 1975. It is possible that there were also a few scattered gull nests on the main island as well.

h. San Clemente Island (including Bird Rock and Castle Rock)

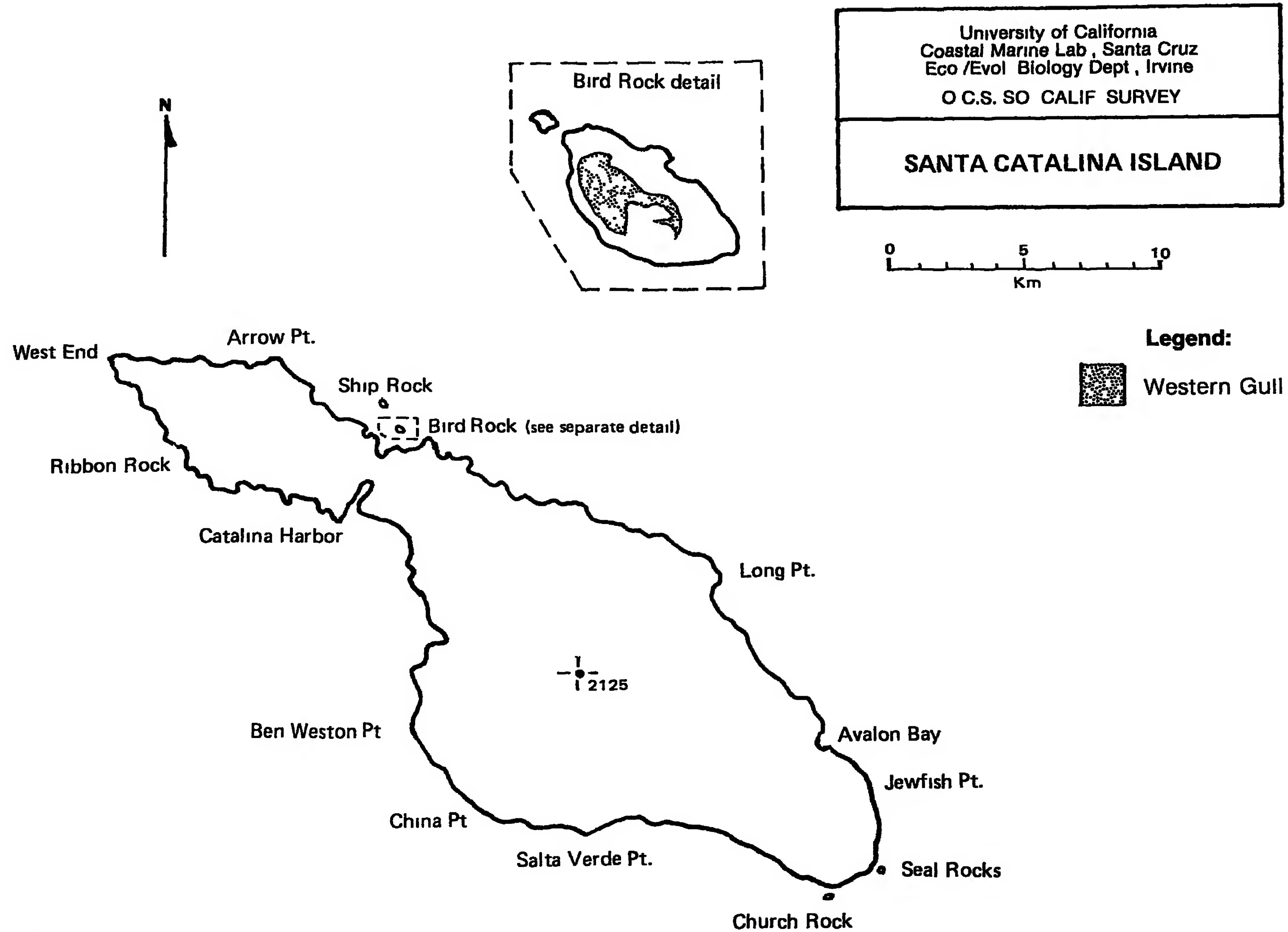

Figure III-194. Distribution of nesting colonies at Santa Catalina Island.

As with the other large islands, the few seabirds which breed here are primarily restricted to offshore rocks and inaccessible sea cliffs. There have been very few ornithological trips to this island for the express purpose of locating seabird colonies, and most data are incidental bits of information collected in addition to other, unrelated work.

1975 data (see Fig. III-195): We found twelve empty, but recently used Brandt's Cormorant nests at Seal Cove on 18 July and one attended nest site on Castle Rk. on 8 May, but no other evidence of breeding. On 8 May we counted 31 active Western Gull nests on the small islet in Northwest Harbor and on 18 July we found a Xantus' Murrelet chick on the water with two adults about 8 km north of Wilson Cove which may have come from San Clemente Is.

i. Synopsis of seabird species breeding on the Channel Islands

In this section we combine our breeding colony findings in 1975 with those of past observers as discussed in Appendix III-A3. Of the eleven seabird species which have bred on the Channel Islands two have disappeared as breeding species in this century; four have clearly diminished in numbers and a fifth may have; three have remained relatively constant, and one may have increased slightly in numbers.

Ashy Storm-Petrel (Oceanodroma homochroa). Evidence at hand suggests that this species may have been formerly more common and widespread on the islands (see Appendix III-A3).
and that its numbers, as well as its distribution, have decreased. Sufficiently accurate documentation of the population of this

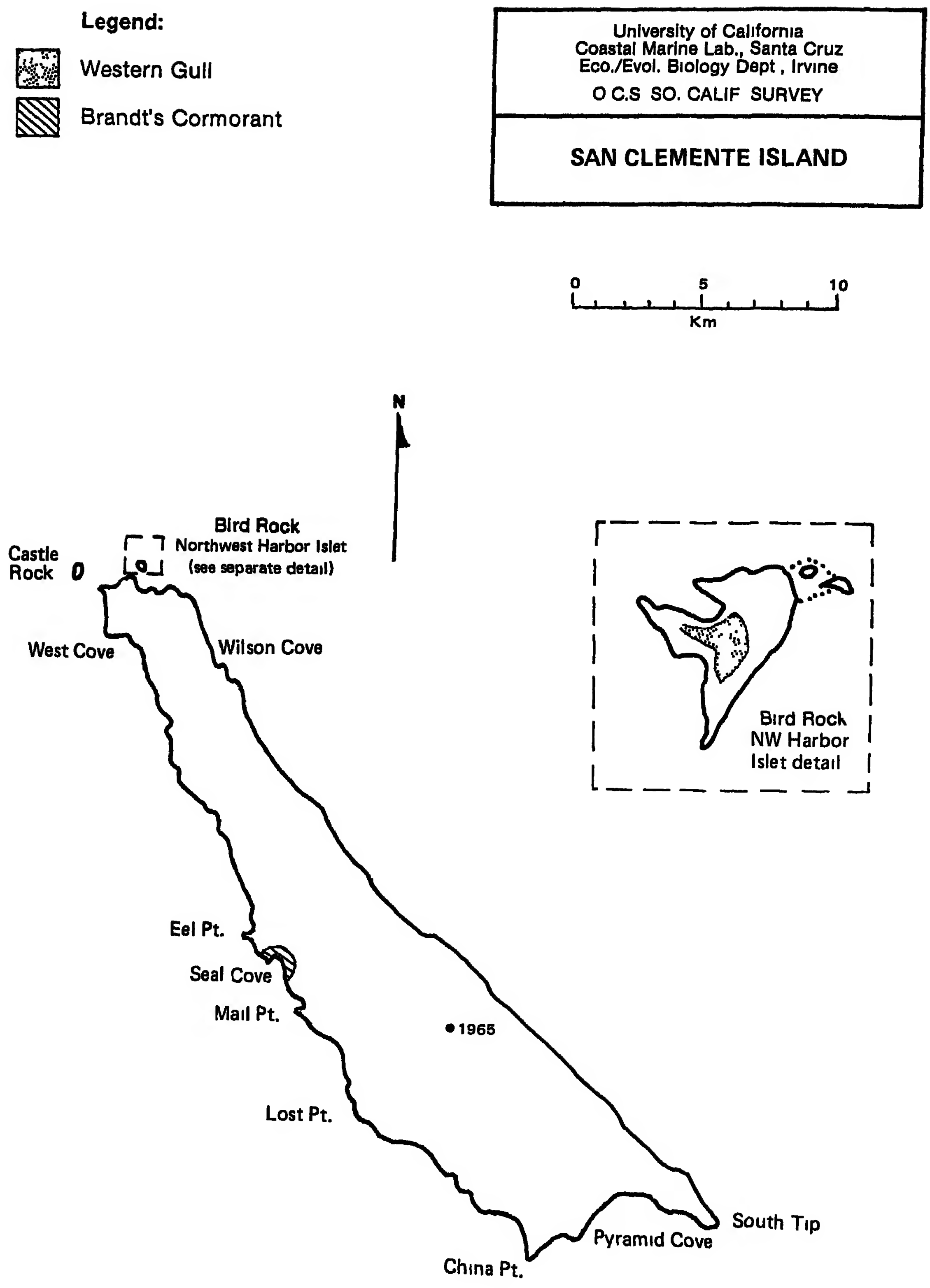

Figure III-195. Distribution of nesting colonies at San Clemente Island.

species for the determination of trends is lacking. All records of breeding have been from 13 May to 27 July. Other records of possible breeders have been from 8 April to 30 August. Nests have been found in burrows and on ledges in a large sea cave.

Brown Pelican (Pelecanus occidentalis). Pelicans nested irregularly on at least three islands in the past and probably regularly on Anacapa Is. (see Appendix III-A3). In recent years their reproductive success has dropped considerably below a level sufficient to maintain a stable population (see Anderson et al. 1975). The timing of breeding varies significantly between sites in any one year and within sites from year to year. For instance, on Anacapa Is. in 1975 they did not begin nesting until May, yet in 1976 they were nesting by mid-March.

Double-crested Cormorant (Phalacrocorax auritus). The numbers of Double-crested Cormorants breeding in southern California have fallen off drastically in recent years as evidenced particularly by the drop from 2,000 to 13 breeding pairs on Santa Barbara Is. between 1939 and 1975 and "very numerous" to 11 breeding pairs on Anacapa Is. between 1939 and 1975 (see Appendix III-A3).

Brandt's Cormorant (Phalacrocorax penicillatus). As with the Double-crested Cormorant, this species has shown a marked decline in numbers since the early 1900's (see Appendix III-A3) however, the decline in Brandt's Cormorant populations has been much less severe and apparently restricted to the colonies on San Miguel, Santa Barbara and probably San Nicolas islands. Evidently it was never a very abundant breeder on Anacapa Is., and historical information on its abundance on Santa Rosa Is. is lacking.

Pelagic Cormorant (Phalacrocorax pelagicus). Although this species was never as abundant on the Channel Islands as the preceding two species (see Appendix III-A3), breeding numbers have nevertheless diminished markedly since the early part of this century. The only "colonies" as such are at San Miguel and perhaps Santa Rosa and Santa Cruz islands.

Western Gull (Larus occidentalis). Western Gulls are the most widespread breeding seabird on the Channel Islands, probably nesting on every island every year. Numbers appear to be about the same as formerly (see Appendix III-A3, though some changes have occurred. Grinnell (1897) mentions immense numbers on Santa Barbara Is., but only "a small colony" on San Nicolas Is. the same year. In 1975 the colony on Santa Barbara Is. was less than twice the size of the one on San Nicolas Island.

Common Murre (Uria aalge). Between 1885 and 1912 about 100 pairs bred on Prince Is. and a few may have bred there sporadically until at least 1939 (see Appendix III-A3). Their disappearance in southern California parallels that of the other large alcids - Tufted Puffin (see pp. III-535) on the Channel Islands and Rhinoceros Auklet farther north (see Ainley and Lewis 1974 for further discussion).

Pigeon Guillemot (Cepphus columba). Numbers have remained fairly constant since the first of the century (see Appendix III-A3). Santa Barbara Is. is the southern limit of its range. All records of this species from the Channel Islands have been between 12 February and 21 August, except for one December record from Santa Catalina Is. where the species does not breed. It is uncertain where this species normally spends the winter.

Xantus' Murrelet (Endomychura hypoleuca). Breeding numbers are probably similar to what they were 75 years ago (see Appendix III-A3), though specific island populations have varied considerably in size. Murrelets may have only recently begun breeding regularly at San Miguel Is., while they only breed in small numbers at best on Anacapa Island. The population on Santa Barbara Is. may have increased in recent years, but this is uncertain. Grinnell's failure to find them there at the height of the breeding season in 1897 suggests that they were not present that year. The breeding record for Santa Catalina Is. suggests, along with the observations of chicks near San Clemente Is. in 1968 and 1975, that a few may be breeding undetected on these large islands.

Cassin's Auklet (Ptychoramphus aleuticus). The large auklet populations at San Miguel Is. are apparently remaining stable. On Santa Barbara Is. proper, however, they were apparently eliminated by cats (see Appendix III-A3. If they were formerly present on Anacapa Is., they were undoubtedly exterminated by black rats (Rattus rattus) which now infest the island. Cassin's Auklets have been reported from their southern California breeding colonies from 15 January until at least 26 July.

Tufted Puffin (Lunda cirrhata). This species disappeared from the Channel Islands some time after 1912 (see Appendix III-A3). It was apparently a common breeder on the northern islands in 1912, but there was little ornithological exploration of the islands between 1912 and 1939, at which date puffins were absent.

2. Distribution, numbers and population movements

In this section we present quarterly overviews of the major groups of seabirds seen during our surveys of the Southern California Bight from April 1975 through March 1976. These are followed by synopses of the distribution and movements of each species that we encountered in 1975- 76. The reader is referred to species accounts in Appendix III-A4 for information supportive of these synopses. [Each account reviews nesting habits and distribution, migration patterns where known, foods exploited, mortality figures when available and status in southern California for each species. Following this review is a month-by-month account of the species' occurrence in the Southern California Bight as determined in our surveys.] Shorebirds are not included, although they were occasionally sighted, primarily because they do not generally alight on the open ocean and are thus less vulnerable to oil contamination while at sea than are more pelagic species. They can, however, become victims to oiling of beaches.

Extensive use is made of figures and tables to clarify the data. The maps represent densities (birds per km^2) obtained along standard ship and aerial tracks. Where the geographically broader aerial data are unavailable, ship data are used. Densities along standard transect segments (ship or air) are considered representative of a 10-minute-square block of latitude and longitude in which the segment's center-point is located and plotted as such on the maps. For uncommon or irregular species, a map showing all the year's sightings is included. Tables are used to show the relative numbers of birds seen throughout the year 1) on island shores or in the

immediately adjacent water and 2) on selected island and mainland beaches.

Birds whose identities could not be determined at the specific level were included in the maps and discussions only if birds of known identity comprised more than 50% of the total number of birds seen in that area; unidentified birds were then apportioned in the same ratio observed for identified birds.

Common abbreviations used are: 1) P.M.T.C., Pacific Missile Test Center, Pt. Mugu, California; 2) POBSP Eastern Grid, waters immediately west of the Channel Islands area (between 31° and 35°N and 121° and 126°30'W) which were sampled by the Pacific Ocean Biological Survey Program in 1966-68; and 3) S.B., State Beach.

The following 15 marine species have been recorded at least once in the Bight, but were not seen by us in 1975-76: Short-tailed Albatross (Diomedea albatrus); Wilson's Storm-Petrel (Oceanites oceanicus); White-tailed Tropicbird (Phaethon lepturus); Magnificent Frigatebird (Fregata magnificens); Brown Booby (Sula leucogaster); Blue-footed Booby (Sula nebouxii); Black Scoter (Oidemia nigra); Oldsquaw (Clangula hyemalis); Harlequin Duck (Histrionicus histrionicus); King Eider (Somateria spectabilis); Glaucous Gull (Larus hyperboreus); Laughing Gull (Larus atricilla); Franklin's Gull (Larus pipixcan); Black Tern (Chlidonias niger); Kittlitz's Murrelet (Brachyramphus brevirostre); and Marbled Murrelet (Brachyramphus marmoratus).

a. Quarterly Summaries

Loons and Grebes (Gaviiformes and Podicipediformes)

We encountered individuals of seven species of loons and grebes. All were primarily winter visitors in southern California waters.

April - June 1975: We found large numbers of this group along mainland beaches surveyed in April and May; most birds migrated north and inland, leaving few behind in June (Table III-116). The primary concentrations along the mainland appeared at Pt. Mugu S.B. and San Onofre S. B.

Our late June aerial survey came too late to sample the northward migration but limited ship coverage in April and May detected substantial numbers of migrating Arctic Loons (Gavia arctica) (to 6 birds/km^2) near Santa Rosa Is. and in San Pedro Channel; lower densities were recorded at scattered locations elsewhere in waters from 5 to 75 km off the mainland (Fig. III-196). It is reasonable to assume that the inter-island channels (San Miguel Passage, Santa Cruz Channel, Anacapa Passage) served as funnels to northward passage of migrating loons and grebes. (A flock of 20+ Arctic Loons was seen feeding near the north end of San Miguel Passage in early June, but no other direct evidence of this sort was obtained.)

July - September 1975: Grebes and loons were virtually absent from the southern California waters we sampled during the summer months. A few birds were present at Pt. Mugu S.B. in July and a few forerunners of the fall migration were seen at P.M.T.C., Pt. Mugu in mid-September (Table III-116). We found none near

Dash indicates beach not surveyed. Numbers in parentheses are lengths of beach surveyed

	Santa Cruz, North	Santa Cruz, West	Santa Cruz, South	McGrath S.B.	P.M.T.C., Pt. Mugu	Pt. Mugu S.B.	Dockweiler S.B.	Huntington S.B.	San Onofre S.B.	South Carlsbad S.B.	Silver Strand S.B.	Border Field S.B.	Totals
	(4.3)	(4.2)	(5.7)	(3.0)	(3.1)	(3.3)	(5.6)	(3.3)	(5.0)	(9.3)	(5.7)	(2.6)	(56.8)
11-27 April, 1975	0	1	0	0	-	232	-	-	626	-	31	30	920
11-24 May	0	0	5	0	-	456	37	50	0	0	0	0	548
13-19 June	1	0	0	0	-	0	0	0	68	0	0	0	69
11-18 July	0	0	0	0	0	5	0	0	0	0	0	0	5
1-7 August	0	0	0	0	0	0	0	0	0	0	0	0	0
11-18 September	0	0	0	0	36	0	1	1	0	0	-	-	38
15-18 October	0	0	0	48	13	1	24	6	0	0	-	-	92
6-14 November	2	0	2	4	122	17	78	1	3	27	210	62	528
4-11 December	7	0	12	332	210	3	760	24	179	58	11	6	1602
11-18 January, 1976	2	3	29	22	216	3	669	595	24	57	53	7	1680
16-24 February	30	24	96	3	353	33	119	522	173	20	74	4	1451
11-22 March	15	3	17	34	286	50	968	494	118	0	11	598	2594

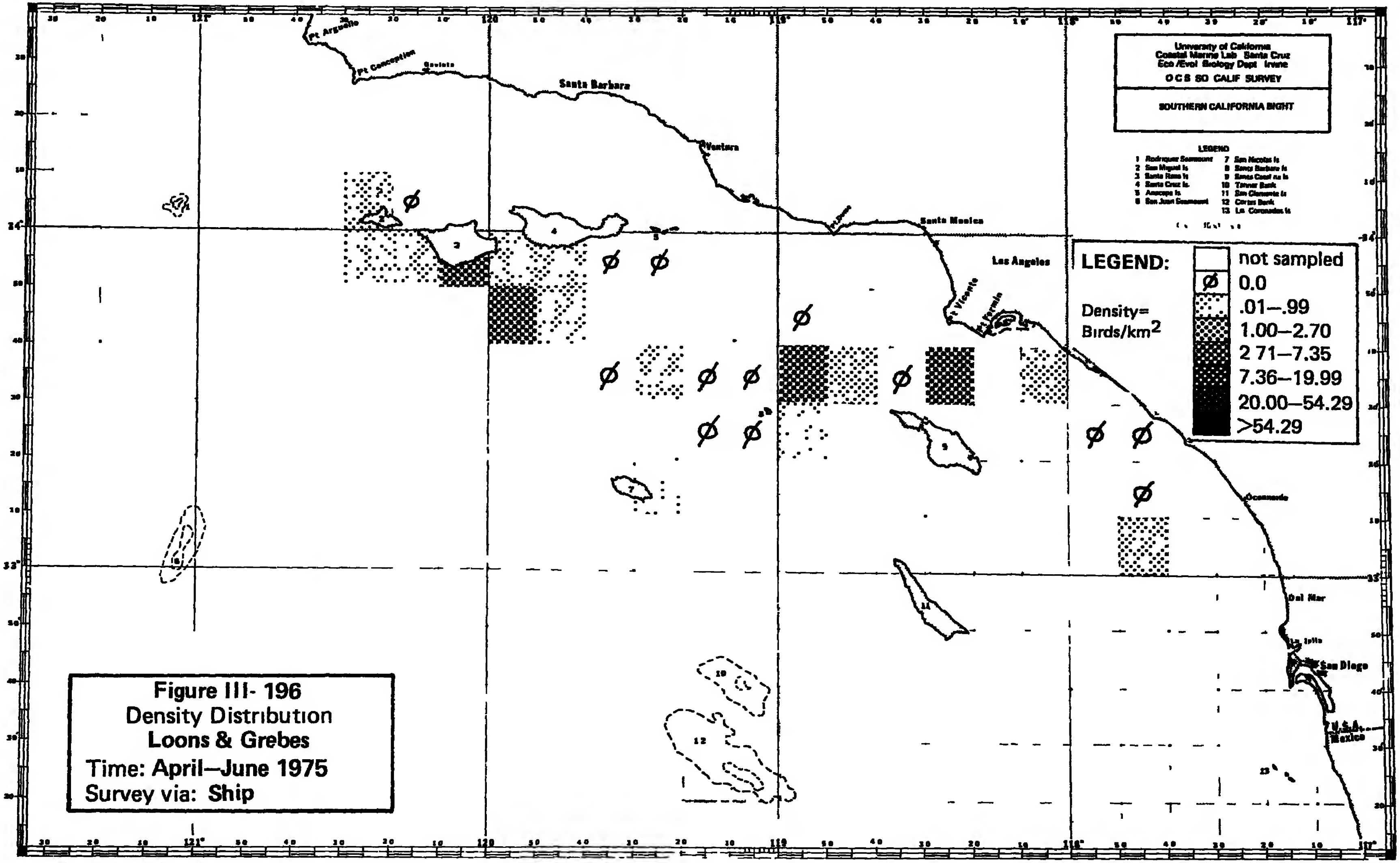

Figure III- 196
Density Distribution
Loons & Grebes
Time: **April–June 1975**
Survey via: **Ship**

Channel Islands' shores and a very few early migrants (probably Arctic Loons) were seen offshore near San Clemente Is. in late September.

October - December 1975: The fall migration of grebes and loons occurred in these months; by the end of the period, large numbers of birds had taken up winter residence along mainland shores, and in open water areas in the northwestern quarter of the study area. Counts of birds on nine mainland beaches rose from a total of 92 individuals in October (all at Ventura, Los Angeles, and Orange Co. beaches) to over 1,600 in December (concentrated in the Pt. Mugu to Palos Verdes area, but many were found in the San Diego area as well) (Table III-117). Few birds were seen among the islands (Table III-116).

Offshore records were many. October and November sightings were primarily of migrating birds, while in December heavy concentrations were found in eastern Santa Barbara Channel--where Red-throated (G. stellata) and Arctic Loons, and Eared and Western Grebes (Podiceps nigricollis and Aechmophorus occidentalis) overwintered by the thousands (Fig. III-197).

January - March 1976: The winter months were the time of peak abundance of members of this group. Large concentrations of grebes and loons were found throughout the period in eastern Santa Barbara Channel (up to 135+/km^2 in the shallow waters from 10 to 25 km west of Ventura), around the four northern islands (Table III-116), especially Santa Rosa, and in San Pedro Channel (Fig. III-198). Along the mainland, substantial numbers of Western and Eared Grebes

Table III-117. Mean frequency (total individuals) of all Loons and Grebes (total individuals) on and near Channel Islands beaches by Quarter of the year April 1975 through March 1976. In the First and Last Quarters, counts are derived by averaging data from flights and inshore ship surveys. Numbers in parentheses following locations refer to specific areas indicated on Figures III-178 through III-185. Dash indicates area not surveyed or survey incomplete. A = Air S = Ship.

Location / Date →	Apr-Jun 75	Jul-Sep 75	Oct-Dec 75	Jan-Mar 76					
Type →	A-2 S-2	A-1	A-2	A-3 S-3					
SAN MIGUEL IS.	NONE RECORDED	NONE RECORDED							
Richardson Rk. (103)			0	0					
West (102,110-20,160,170)			0	14					
South (146-51)			2	65					
East (101,140-45)			0	2					
North (121-40)			0	201					
SANTA ROSA IS.									
West (611-12,625)			31	8					
South (620-24)			0	2320					
East (618-19,629)			0	155					
North (610,613-17)			0	14					
SANTA CRUZ IS.									
West (641,658)			0	23					
South (650,653-56)			0	228					
East (649,651)			0	3					
North (640,643-48)			0	40					
ANACAPA IS. (660-80)			-	32					
SAN NICOLAS IS.									
Northwest (210-60)			0	0					
Southwest (203)			0	0					
Southeast (202)			0	3					
Northeast (201)			0	0					
SANTA BARBARA IS.(300-330)			0	93					
SANTA CATALINA IS.									
Northwest (506-07,515, 525-27)			0	0					
Southwest (503-05,529)			1	0					
South (502,523-24)			0	1					
East (501,509-11)			0	5					
Isthmus (508,521-522)			0	18					
SAN CLEMENTE IS.									
Northwest (409-11)			0	2					
West Central (406-08)			3	30					
Southwest 404-05)			0	0					
Pyramid Cove (402-03)			0	0					
East 401,412)			0	0					

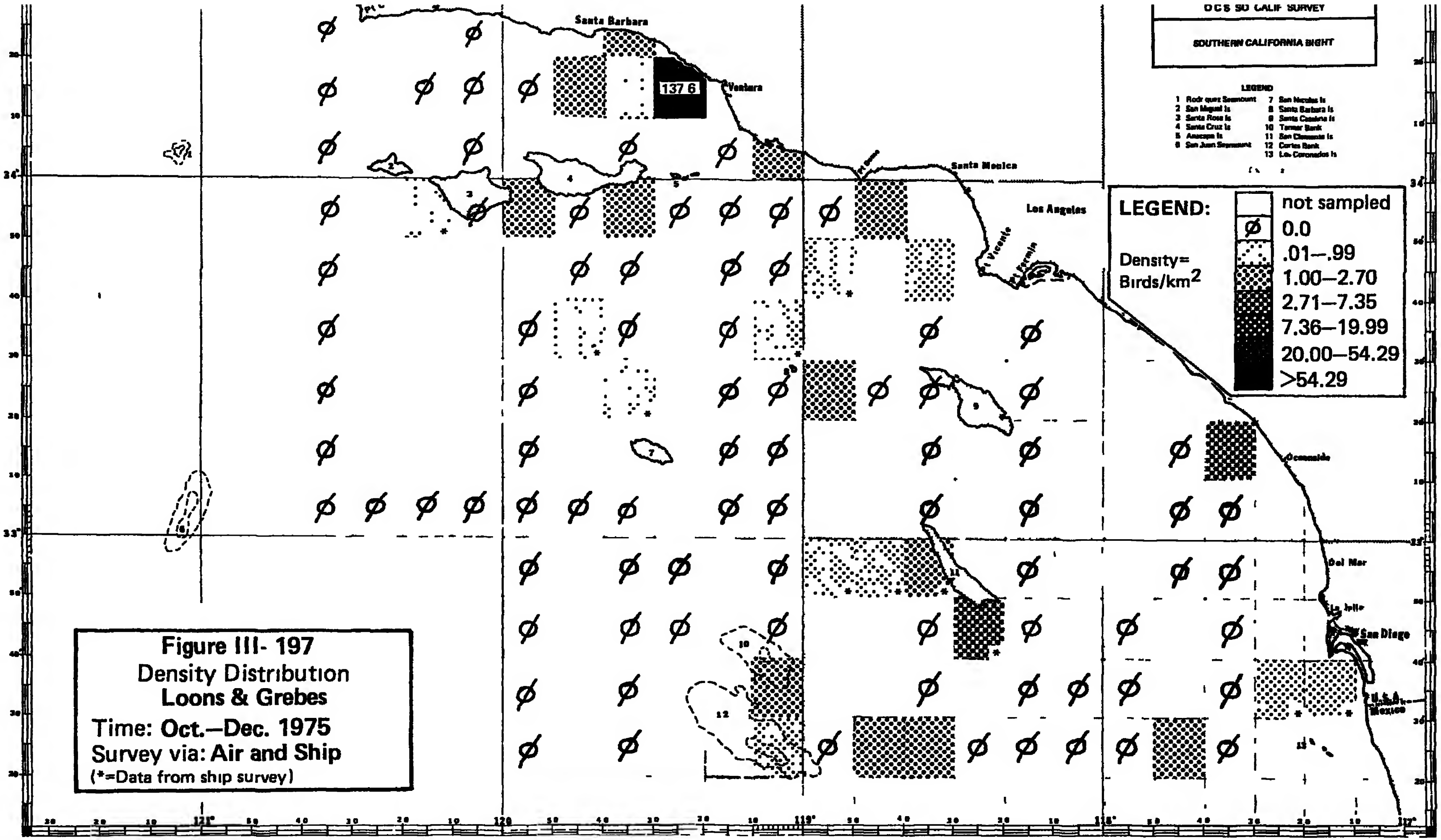

Figure III- 197
Density Distribution
Loons & Grebes
Time: Oct.—Dec. 1975
Survey via: Air and Ship
(*=Data from ship survey)

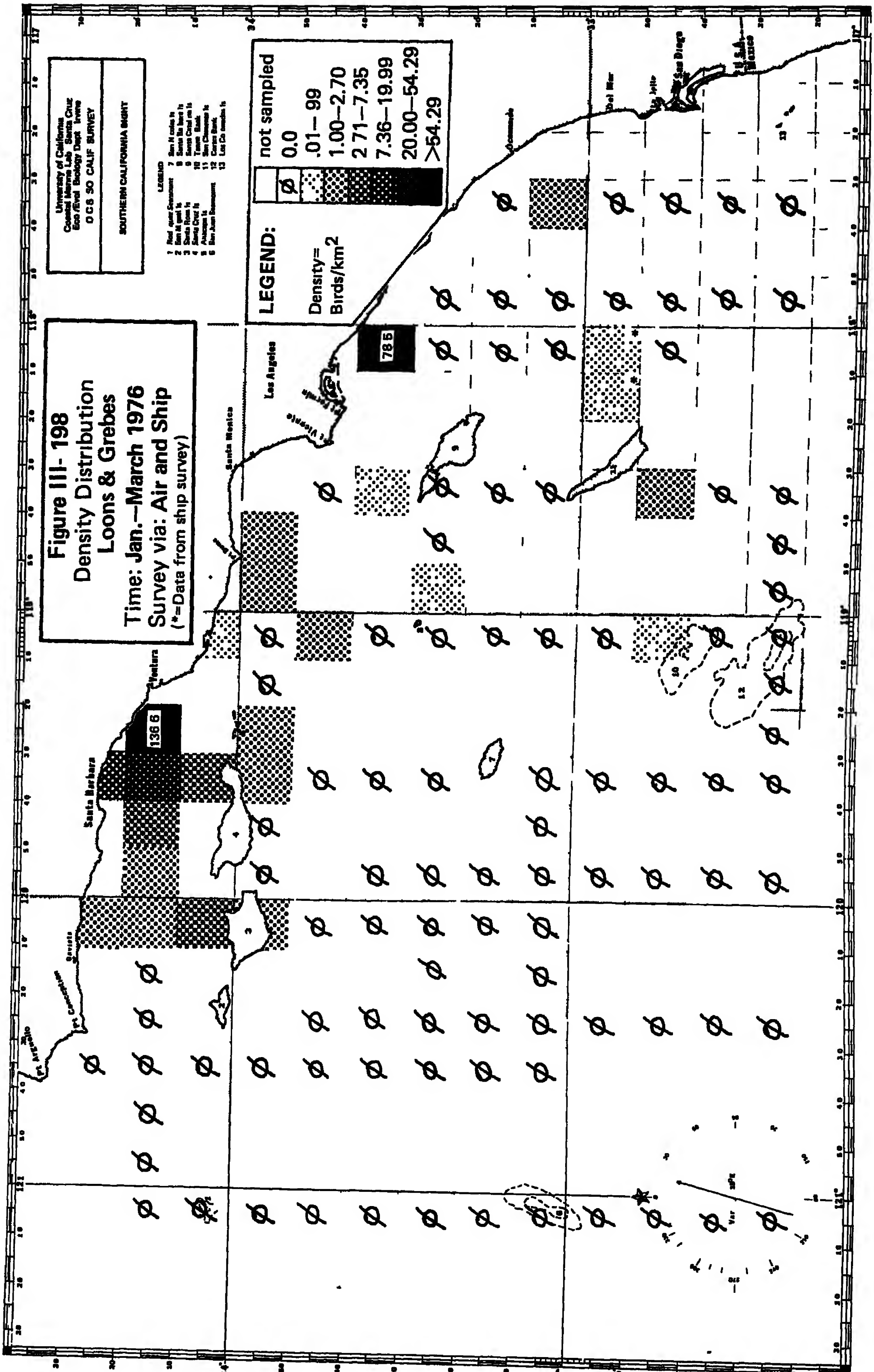

Figure III- 198
Density Distribution
Loons & Grebes
Time: Jan.–March 1976
Survey via: Air and Ship
(*=Data from ship survey)

were found at Pt. Mugu (two beaches), Playa del Rey, and Huntington Beach throughout the winter (Table III-117). San Diego beaches harbored fewer of these birds (though many hundreds overwintered in local bays and estuaries not censused in this study) except in March, when over 600 Western Grebes were counted. These birds may well have been passing northward from Mexican waters, or, alternatively, may have been part of the large over-wintering population in San Diego Bay that was moving to the outer coast preparatory to migration.

Albatrosses, Shearwaters, and Storm-Petrels (Procellariiformes)

We recorded sightings of 12 species of this order in 1975-76. One of these, the Sooty Shearwater (Puffinus griseus) was probably the most abundant seabird in the waters of the study area from April through September.

April - June 1975: The main thrust of northward migration of Sooty Shearwaters occurred in these months, resulting in extremely high overall density figures in some areas (Fig. III-199). Very large numbers of shearwaters (including some Pink-footed Shearwaters, P. creatopus) were found in western Santa Barbara Channel, in Santa Cruz Basin (up to 500+ birds/km^2), between San Nicolas and San Clemente islands, and in San Pedro Channel (Fig. III-199). Sooty Shearwaters were concentrated west of longitude 118°30'W while Pink-footed Shearwaters were found in rather uniform, low densities throughout the area east and southeast of Santa Barbara Island.

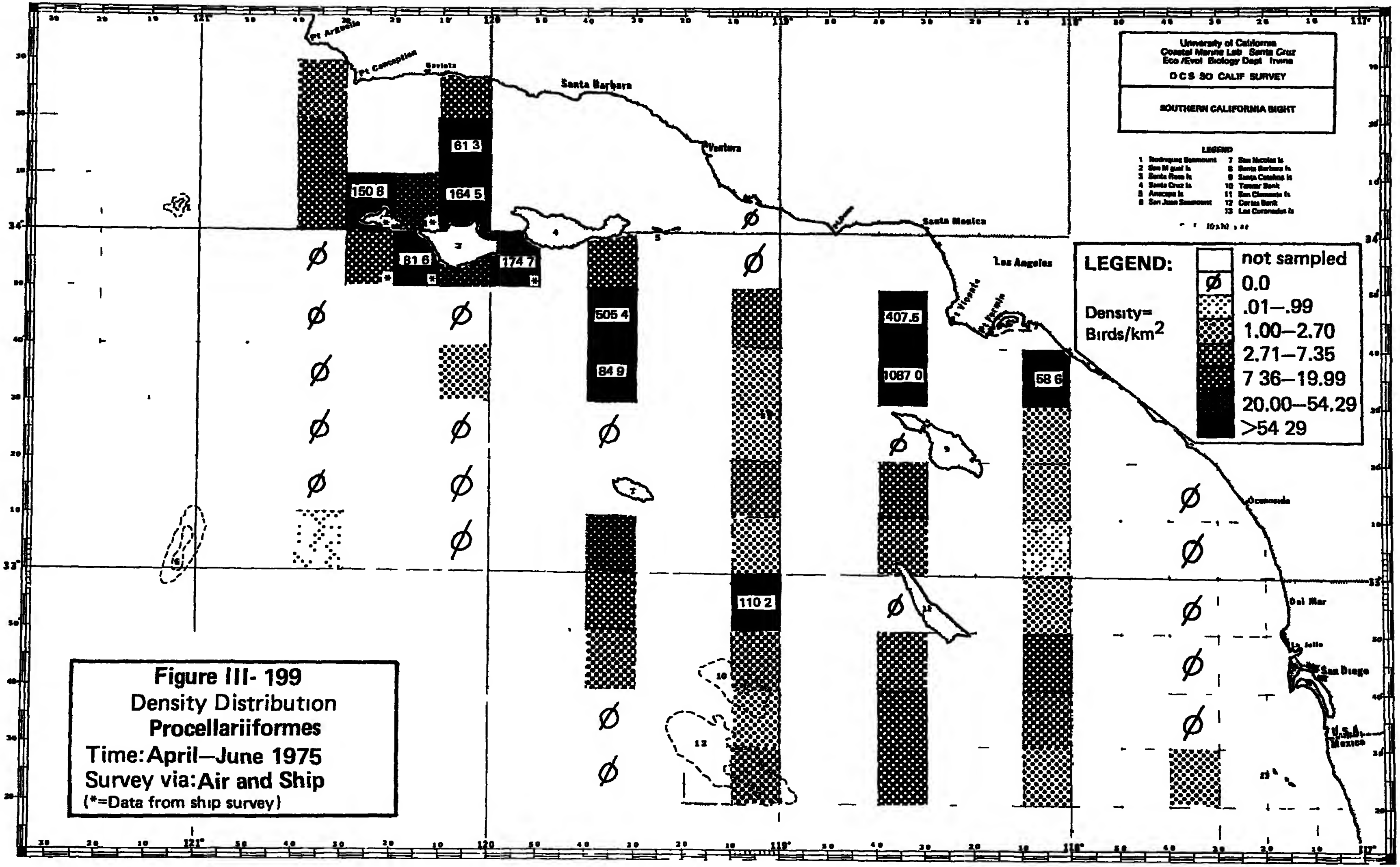

Figure III- 199
Density Distribution
Procellariiformes
Time: April—June 1975
Survey via: Air and Ship
(*=Data from ship survey)

Little information was obtained from the waters west of the Santa Rosa-Cortés Ridge, but the numbers of birds of this group appeared to be small compared to more inshore areas.

Storm-Petrels (primarily Leach's, Oceanodroma leucorhoa, with a scattering of Black and Ashy, Oceanodroma melania and O. homochroa, respectively) were not numerous compared to the procellariids. The only areas in which storm-petrels were common were the immediate vicinity of San Miguel Is., the northern Santa Rosa-Cortés Ridge, and Fortymile and Thirtymile Banks.

July - September 1975. A mid-summer massing of Sooty Shearwaters in the vicinity of the four northern Channel Islands and Santa Cruz Basin-northern Santa Rosa-Cortés Ridge led to elevated densities of Procellariiformes in the northwestern quarter of the study area (Fig. III-200). Particularly high densities were encountered near Pt. Conception, from 10 to 50 km southeast of Santa Rosa Is., and 45 km west of San Clemente Is. Storm-Petrels (particularly Leach's and Black) concentrated in these same areas and approximately 40 km southwest of San Diego. Throughout this period shearwaters and storm-petrels were much less numerous within 75 km of the mainland between Pt. Dume and La Jolla than elsewhere.

In September, Sooty Shearwaters declined in abundance in the study area, apparently departing to the west and southwest. (See Figs. III-A4-269 and 273) and related discussion of directionality of movements and concentration areas of

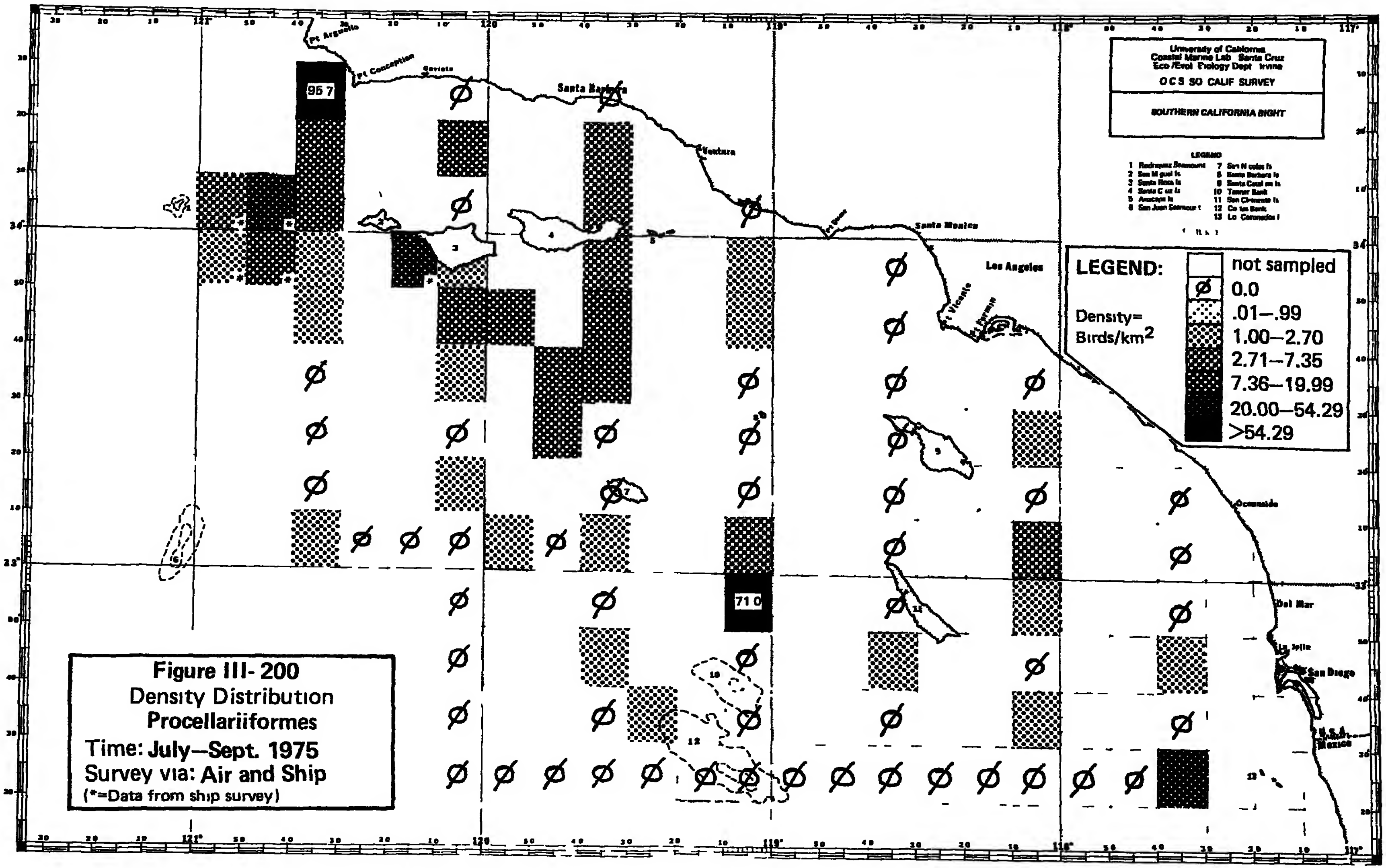

Figure III-200
Density Distribution
Procellariiformes
Time: July–Sept. 1975
Survey via: Air and Ship
(*=Data from ship survey)

Sooty Shearwaters.) A few Black-footed Albatross (Diomedea nigripes) were seen in this month near Cortés and Tanner Banks.

October - December 1975. With the exception of small-scale concentrations of shearwaters and storm-petrels near Cortés Bank and Thirtymile Bank, the density of tubenoses was low throughout the study area (Fig. III-201). The last major migratory activity of Sooty Shearwaters terminated in early October. Small numbers of Northern Fulmars (Fulmarus glacialis) were seen at scattered locations from 90 to 175 km offshore, but in nothing approaching the densities recorded in the following months (January through March).

January - March 1976. The combined numbers of procellariids increased somewhat in the winter over those of the preceding three months. A major influx of Northern Fulmars occurred in waters west of longitude 119°30'W, in Santa Barbara Channel, and near Cortés Bank (Fig. III-202). Overall densities were far below those encountered in spring and summer 1975, however, owing to the near absence of other species within this group. Few shearwaters were seen, the Sooty Shearwater being much less abundant than the Pink-footed Shearwater. Storm-Petrels were quite uncommon in these months in all areas that we surveyed.

Pelicans, Cormorants and Tropicbirds (Pelecaniformes)

April - June 1975: Four species of this group -- Double-crested, Brandt's and Pelagic Cormorants, and Brown Pelican -- nested in the Channel Islands in April through June. Their activities and total numbers throughout the Southern California Bight

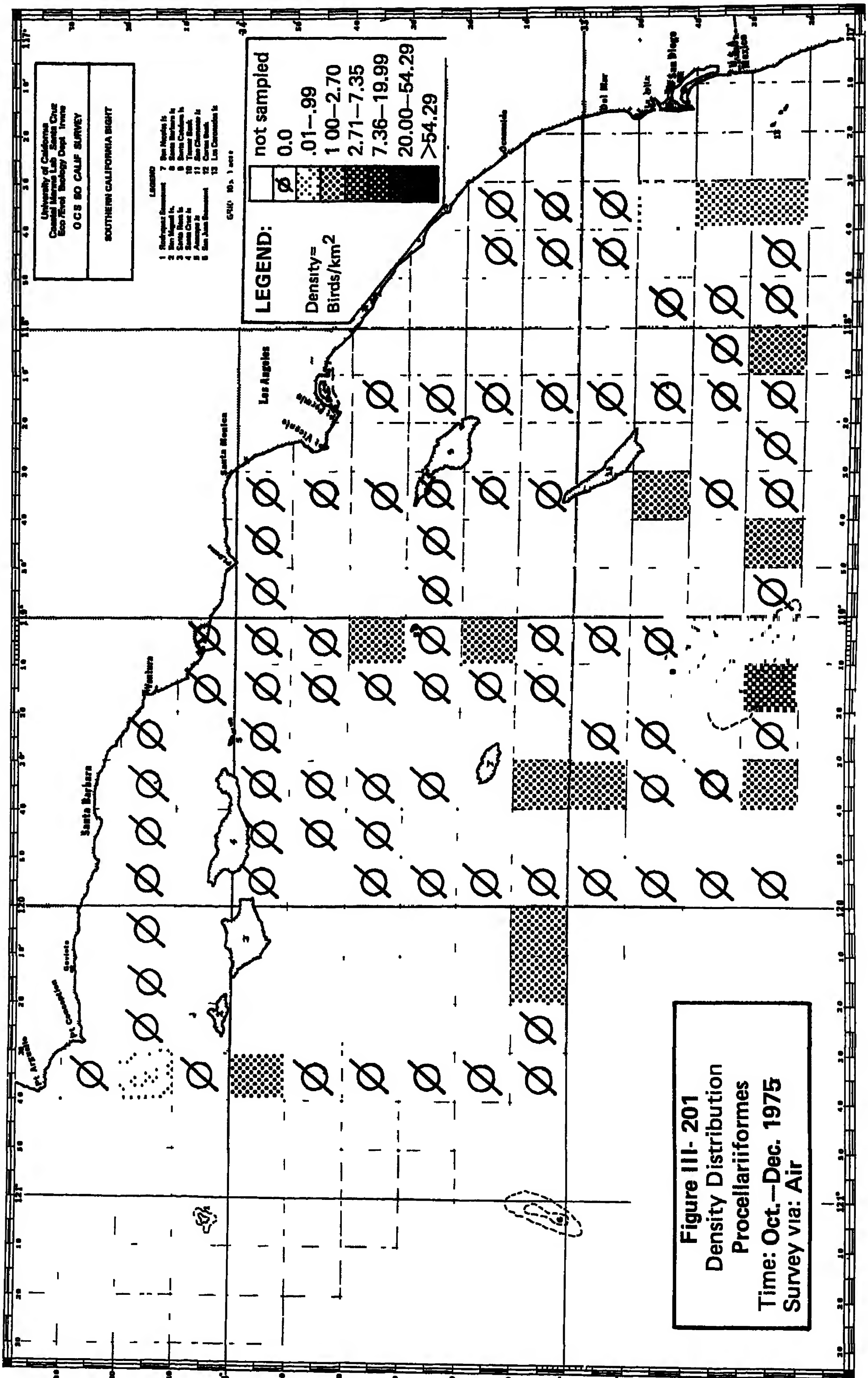

Figure III- 201
Density Distribution
Procellariiformes
Time: Oct.—Dec. 1975
Survey via: Air

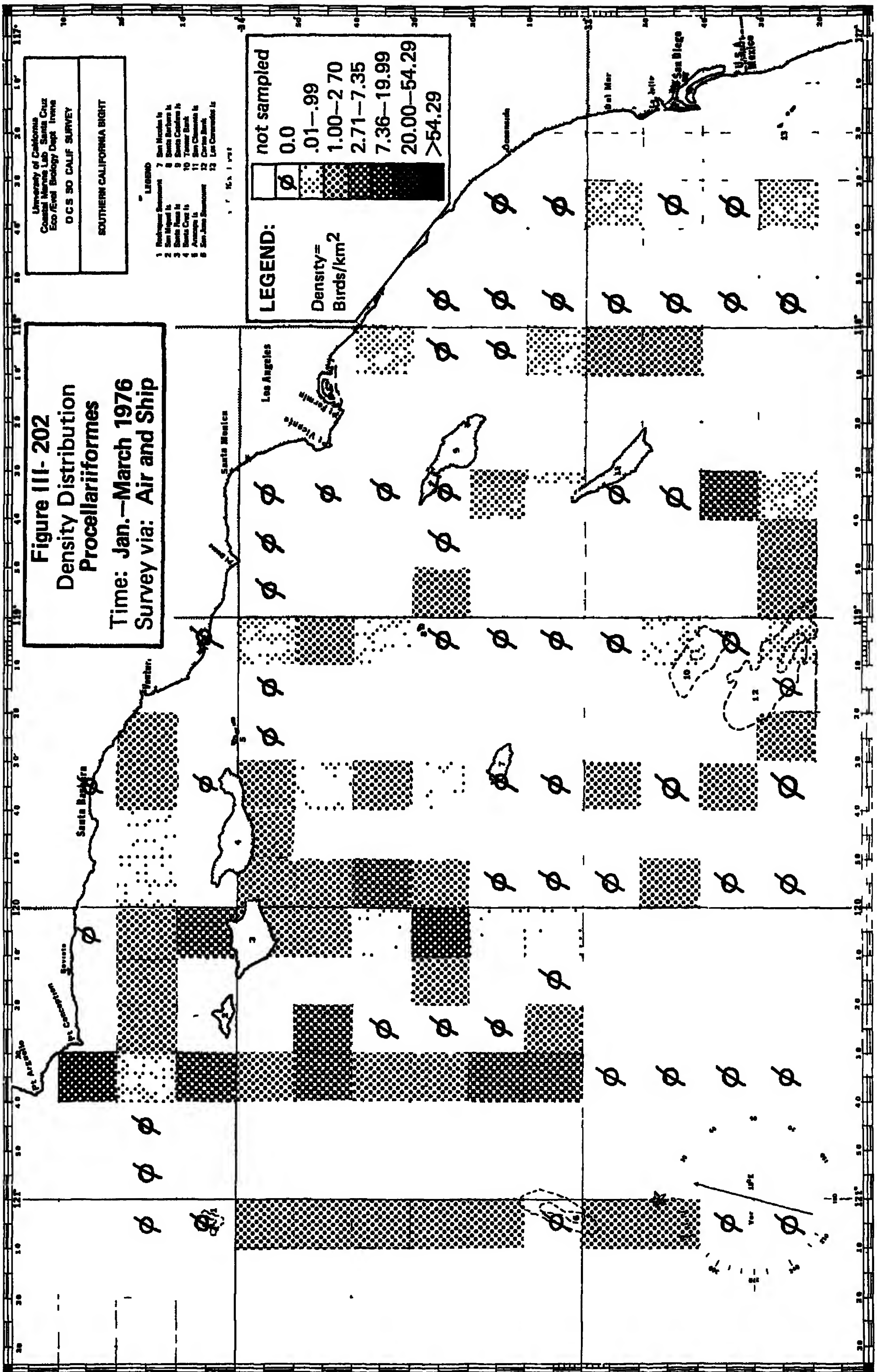

Figure III- 202
Density Distribution
Procellariiformes
Time: Jan.—March 1976
Survey via: Air and Ship
LEGEND:
not sampled
0.0
.01—.99
1.00—2.70
2.71—7.35
7.36—19.99
20.00—54.29
>54.29
Density=
Birds/km^2
SOUTHERN CALIFORNIA BIGHT
Los Angeles
Santa Monica
Santa Barbara
Del Mar
San Diego

were concentrated near the large colonies among the four northern islands, and San Nicolas and Santa Barbara islands; few were seen at sea more than 2-3 km from these islands (Fig. III-203). Likewise, members of this group were scarce near shore along the mainland beaches included in our censuses.

Numbers of cormorants and pelicans were largest at San Miguel Is. (an average of 3,620 birds of four species from two aerial and one ship census); at Santa Rosa, Santa Cruz, and Anacapa islands we counted from 850 to 1,000 birds each (Table III-118). Lesser numbers were seen at the four remaining islands.

These birds concentrated their foraging activities close to shore near their nesting colonies. Actively feeding birds were seen as follows: four Brandt's Cormorants, 6 km northeast of Santa Barbara Is. on 9 May; six Brandt's Cormorants, from 2 to 11 km northwest of Castle Rock, San Miguel Is. on 13 May; several hundred Brandt's and Double-crested Cormorants, 1 km off Cardwell Pt. in San Miguel Passage on 1 June; one Brown Pelican in Anacapa Passage on 28 June.

July - September 1975: We found pelicans and cormorants scattered in relatively uniform, low densities throughout the waters of the study area (Fig. III-204), concentrating near Anacapa and Santa Barbara islands. This increase in at-sea density was largely the product of immigration of Brown Pelicans from nesting colonies in Mexican waters and emancipation of locally nesting Brandt's Cormorants and Brown Pelicans from the immediate vicinity of their nesting colonies at the end of the fledging

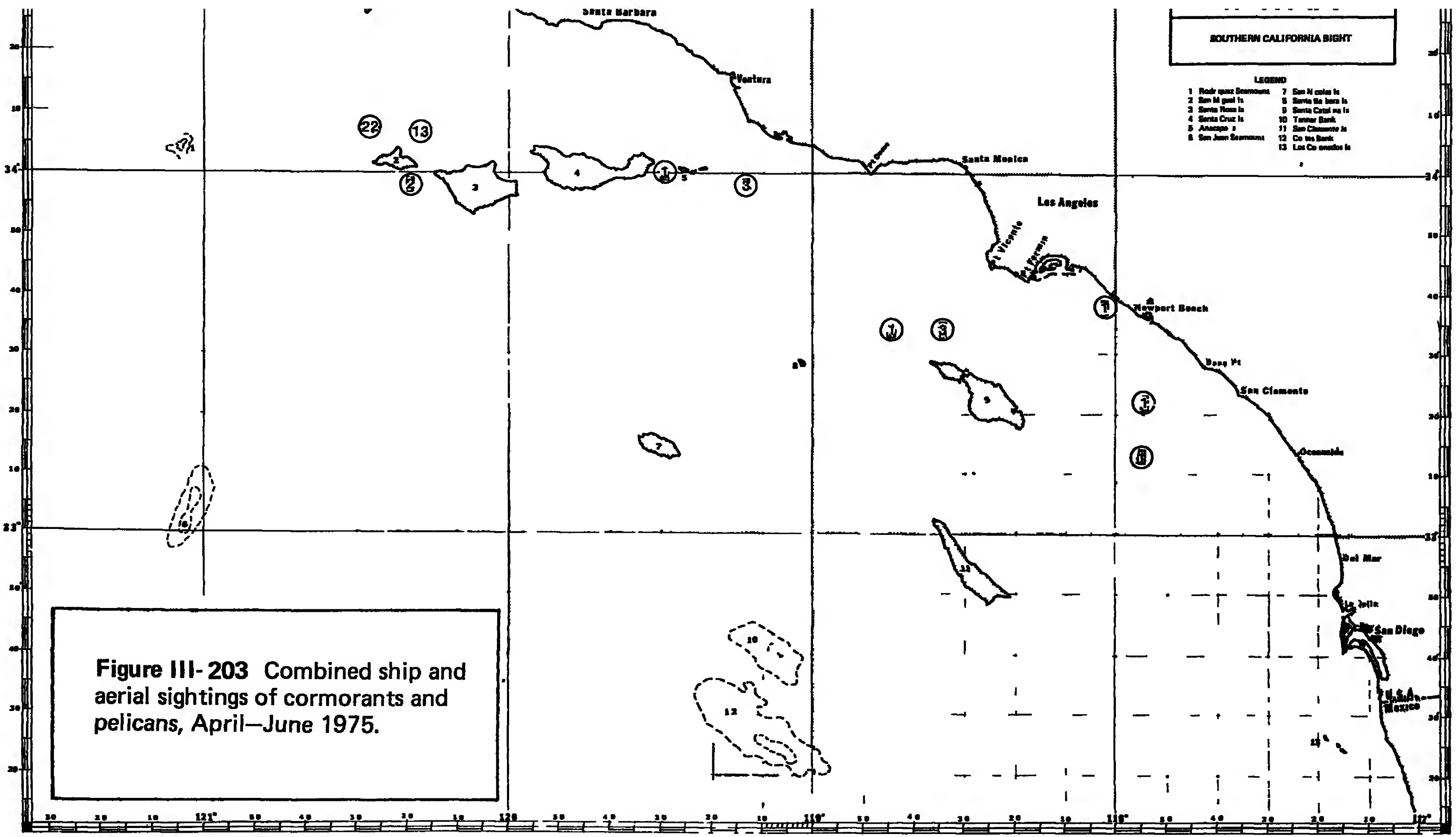

Figure III-203 Combined ship and aerial sightings of cormorants and pelicans, April—June 1975.

Table III-118. Mean frequency (total individuals) of all Cormorants and Pelicans on and near Channel Islands beaches by Quarter of the year April 1975 through March 1976. In the First and Last Quarters, counts are derived by averaging data from flights and inshore ship surveys. Numbers in parentheses following locations refer to specific areas indicated on Figures III-178 through III-185. Dash indicates area not surveyed or survey incomplete. A=Air S=Ship.

Location / Date→	Apr-Jun 75	Jul-Sep 75	Oct-Dec 75	Jan-Mar 76
Type→	A-2 S-1	A-1	A-2	A-3 S-3
SAN MIGUEL IS.				
Richardson Rk. (103)	0	221	157	50
West (102,110-20,160,170)	919	1047	1242	411
South (146-51)	241	22	311	47
East (101,140-45)	1188	249	2003	350
North (121-40)	292	222	226	117
SANTA ROSA IS.				
West (611-12,625)	185	49	1164	322
South (620-24)	43	60	534	847
East (618-19,629)	145	429	230	194
North (610,613-17)	606	433	632	197
SANTA CRUZ IS.				
West (641,658)	103	210	493	32
South (650,653-56)	179	240	442	642
East (649,651)	312	217	924	131
North (640,643-48)	401	257	519	133
ANACAPA IS. (660-80)	862	-	-	1156
SAN NICOLAS IS.				
Northwest (210-60)	105	503	968	382
Southwest (203)	0	25	50	28
Southeast (202)	0	0	255	626
Northeast (201)	125	215	280	105
SANTA BARBARA IS.(300-330)	206	453	1663	624
SANTA CATALINA IS.				
Northwest (506-07,515, 525-27)	0	25	24	62
Southwest (503-05,529)	19	0	3	44
South (502,523-24)	8	1	3	46
East (501,509-11)	11	0	0	251
Isthmus (508,521-522)	17	0	4	240
SAN CLEMENTE IS.				
Northwest (409-11)	137	433	686	1020
West Central (406-08)	15	94	255	92
Southwest 404-05)	6	5	5	0
Pyramid Cove (402-03)	0	0	2	0
East 401,412)	3	-	-	11

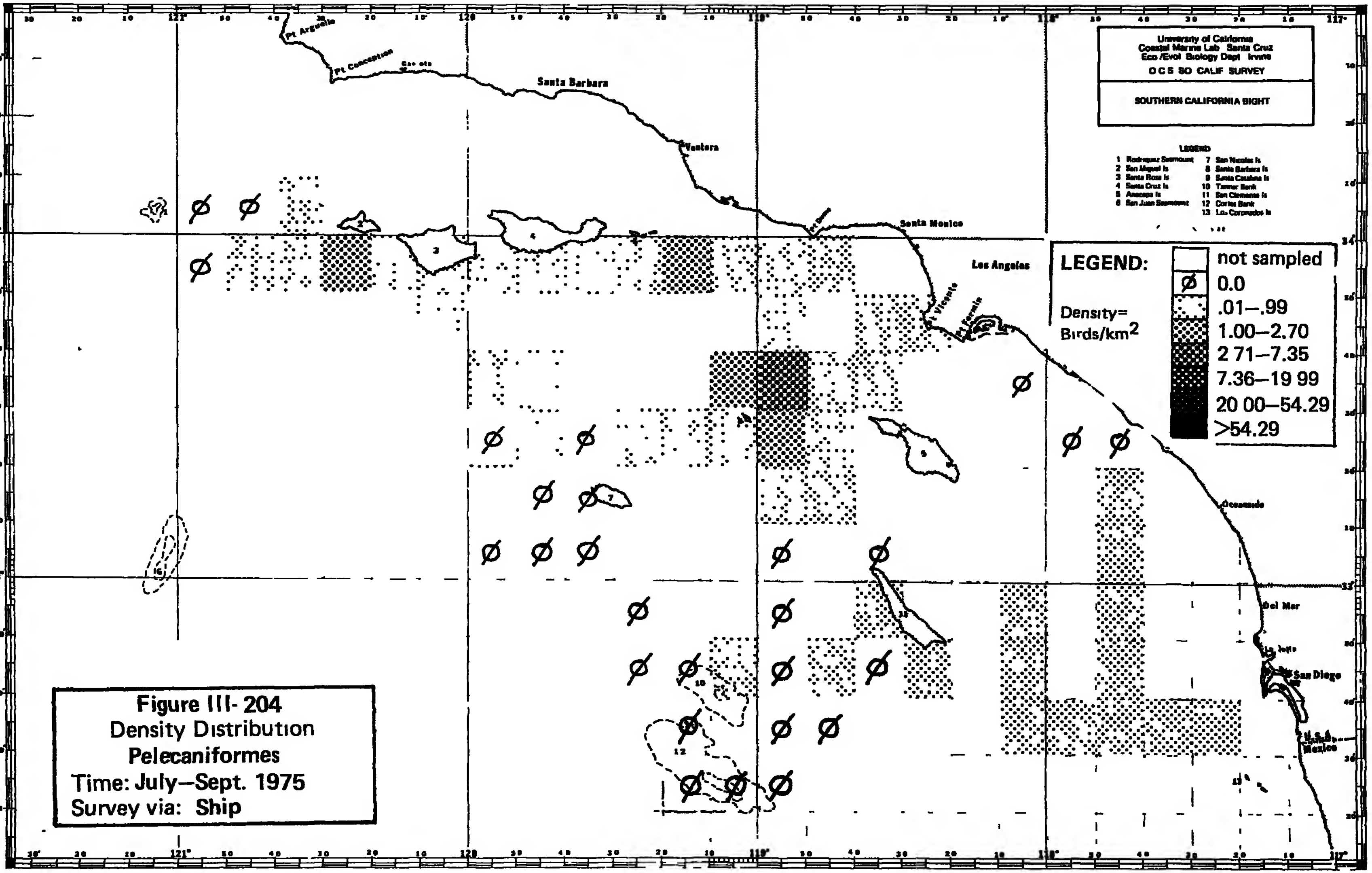

Figure III-204
Density Distribution
Pelecaniformes
Time: July–Sept. 1975
Survey via: Ship

period of their young (July and August). A small number of sightings of Red-billed Tropicbirds was recorded in July through September, primarily from waters overlying the Santa Rosa-Cortés Ridge.

Substantial numbers of Brown Pelicans moved into roosts among the islands through this period (Table III-118) as did Brandt's and Double-crested Cormorants. San Miguel Is. harbored over 1,500 birds of this group in August, and close to 1,000 each resided at Santa Rosa and Santa Cruz Is. as well (Table III-118). A sizeable roost of cormorants and pelicans formed in July at the small rock in Northwest Harbor, San Clemente Is. This roost increased in importance in subsequent seasons.

October - December 1975: The total numbers of pelicans and cormorants reached the yearly highs, both at sea and near Channel Island beaches, in October. An average of over 8,800 birds (results of October and December surveys combined) was found at San Miguel, Santa Rosa, and Santa Cruz islands (Anacapa was not censused) and well over 1,500 each were found at San Nicolas and Santa Barbara Islands as well (Table III-118). The roost at Northwest Harbor, San Clemente Is., increased to an average of almost 700 birds.

These large island totals were matched by concentrations in several open-ocean areas. The waters from Santa Cruz Channel east to longitude 119°W and 2 to 20 km offshore harbored substantial numbers of these birds (up to 20 to 25/km^2). Lower, but still substantial densities were recorded near San Clemente and

Santa Catalina islands (Fig. III-205); the area west of the Santa Rosa-Cortés Ridge apparently was not visited by cormorants or pelicans. Pelicans were also seen at scattered locations near Cortés Bank, Fortymile Bank, and off the Orange Co. coastline.

For the most part, records of this group away from the vicinity of the islands or mainland coast were of Brown Pelicans that appeared to be undergoing the return southward migration toward Mexican nesting areas. By late December the numbers of this species declined considerably throughout the study area.

January - March 1976: The total numbers of this group appeared to decline in the Southern California Bight in the winter months. Important concentrations were noted at sea in eastern Santa Barbara Channel, from 2 to 20 km north and south of Santa Rosa and Santa Cruz islands, and between Santa Catalina and San Clemente islands (Fig. III-206). Pelicans and cormorants were scarce elsewhere at sea and on the mainland beaches included in our surveys.

Roosts among the Channel Islands continued to harbor several thousand birds; relatively fewer were seen at San Miguel Is. than in previous periods, while the roost at Northwest Harbor, San Clemente Is. averaged over 1,000 individuals during two aerial surveys (Table III-118). In March, the majority of Brown Pelicans at the latter roost was of immature birds, whereas near the nesting areas at Anacapa and eastern Santa Cruz islands adults predominated. This was the only season in which important roosts of pelicans and cormorants were found at Santa Catalina Island.

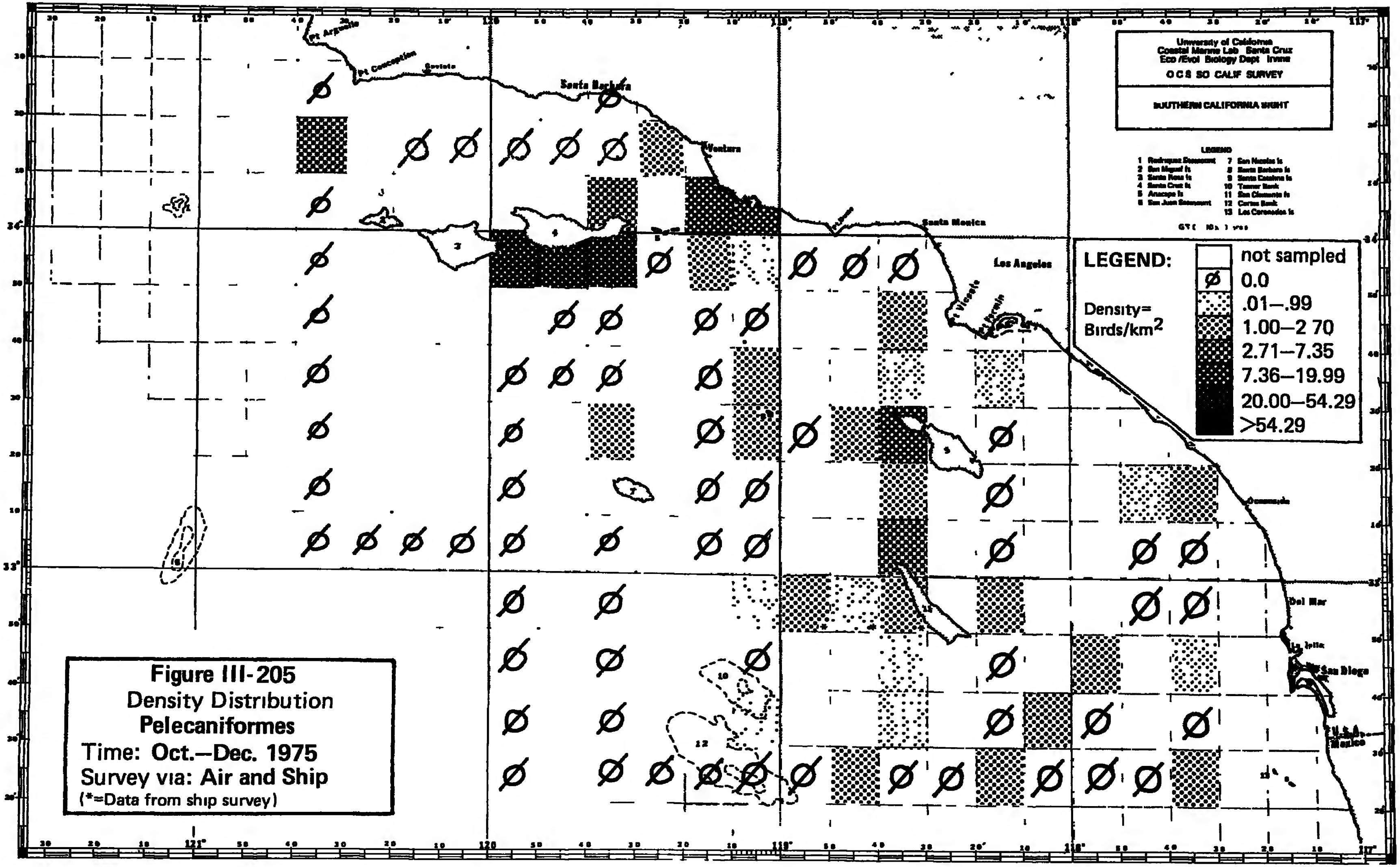

Figure III-205
Density Distribution
Pelecaniformes
Time: Oct.–Dec. 1975
Survey via: Air and Ship
(*=Data from ship survey)

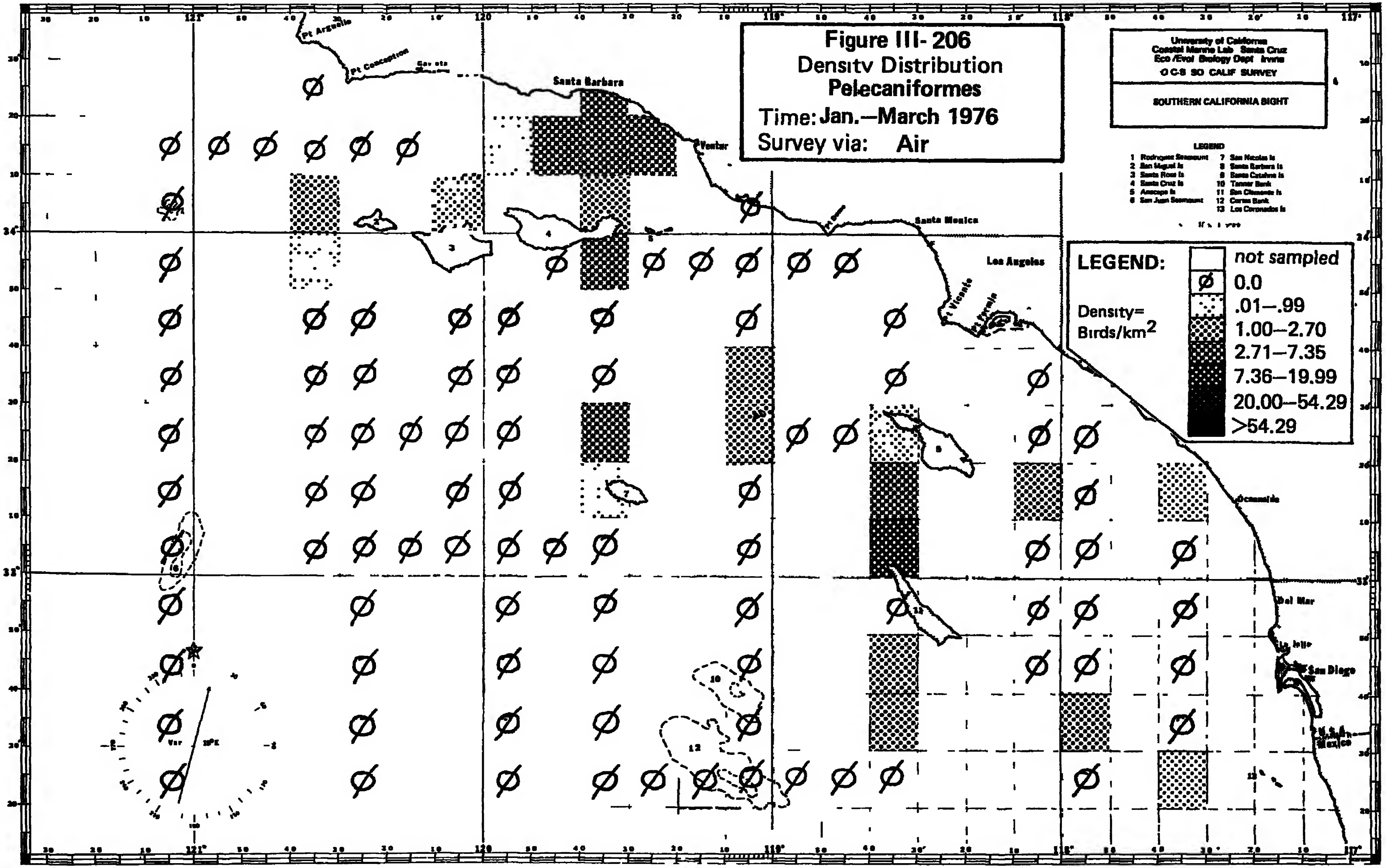

Figure III- 206
Density Distribution
Pelecaniformes
Time: Jan.—March 1976
Survey via: Air

It may be assumed that these species foraged in areas relatively close (1-20 km) to their large Channel Islands roosts. In addition, we documented feeding activity in eastern Santa Barbara Channel in mid-January (mixed-species feeding flocks including gulls, murres, and California sea lions numbering several thousand individuals), and at Santa Catalina Is. in January and February. Birds at the latter area were feeding on spawning squid (presumably Loligo sp.).

Geese, Scoters, and Mergansers (Anseriformes)

Four species of this order, including one goose, two scoters and one merganser were recorded regularly on marine waters of the Southern California Bight in 1975-76. Several other species were observed irregularly, but will not be discussed here.

April - June 1975. This period was marked by the major northward movement of anseriforms from wintering areas to the northern breeding grounds. In April, the last flocks of Brant (Branta bernicla) were observed in transit through the Bight. Scattered individuals and small flocks of Surf and White-winged Scoters (Melanitta perspicillata and M. deglandi) and Red-breasted Mergansers (Mergus serrator) present along the mainland coast in April and May, had departed by June. Low numbers were observed inshore around the islands and at sea throughout the period (Table III-119).

July - September 1975. Anseriforms were virtually absent from the study area in the summer months. A few birds observed along the mainland coast and inshore at Santa Cruz Is. were the only records.

October - December 1975. The autumn months marked the return and subsequent build-up in number in the study area of anseriforms.

Table III-119. Frequency of sightings (total individuals) of Anseriformes (scoters, mergansers, Brant) on Channel Islands beaches in April through June and October through December 1975. Results are averages of data from two aerial and three ship surveys in April - June and two aerial surveys in October - December. Numbers in parentheses refer to specific locations on Figs. III-178 through III-185.

Period	Location	Number
April - June	San Miguel Is. north (121-140)	2
	San Miguel Is. south (146-151)	5
	Santa Cruz Is. south (650, 653-56)	4
	San Nicolas Is. southwest (203)	1
	Santa Barbara Is.	6
October - December	Santa Rosa Is. west (611-12, 625)	4
	Santa Rosa Is. south (620-24)	7
	Santa Rosa Is. east (618-19, 639)	7

In October and November, increasing numbers of scoters and mergansers began to show up along the mainland coast. November produced the highest numbers of offshore records as Surf Scoters were concentrated 5 to 10 km south of the northern islands, and 5-20 km north and northeast of Santa Barbara Is. A southbound flock of Brant was observed 15 to 20 km west of San Clemente Is. (Fig. III-207). By December, scoters and mergansers had become moderately abundant along the mainland coast and inshore on the south side of the northern islands (Table III-120). Offshore records were few in December.

January - March 1976. Peak numbers of anseriforms were recorded during these months. A gradual displacement of these birds from the mainland coast to inshore areas of the islands (especially the northern islands) perhaps reflected improving weather conditions and the onset of spring migration. In January, scoters and mergansers were abundant along the mainland coast and inshore areas of the northern islands. Numbers decreased along the mainland coast in February, and the birds became more abundant and widespread on island inshore waters (Table III-120). Although numbers of birds on island inshore waters continued to increase in March, their distribution was more restricted, with exceptionally large concentrations (primarily Surf Scoters) observed inshore south and east of Santa Rosa Is. in mid-month (Table III-121).

During these months, Surf Scoters were by far the most abundant waterfowl in the area; White-winged Scoters and Red-breasted Mergansers were encountered in lesser numbers.

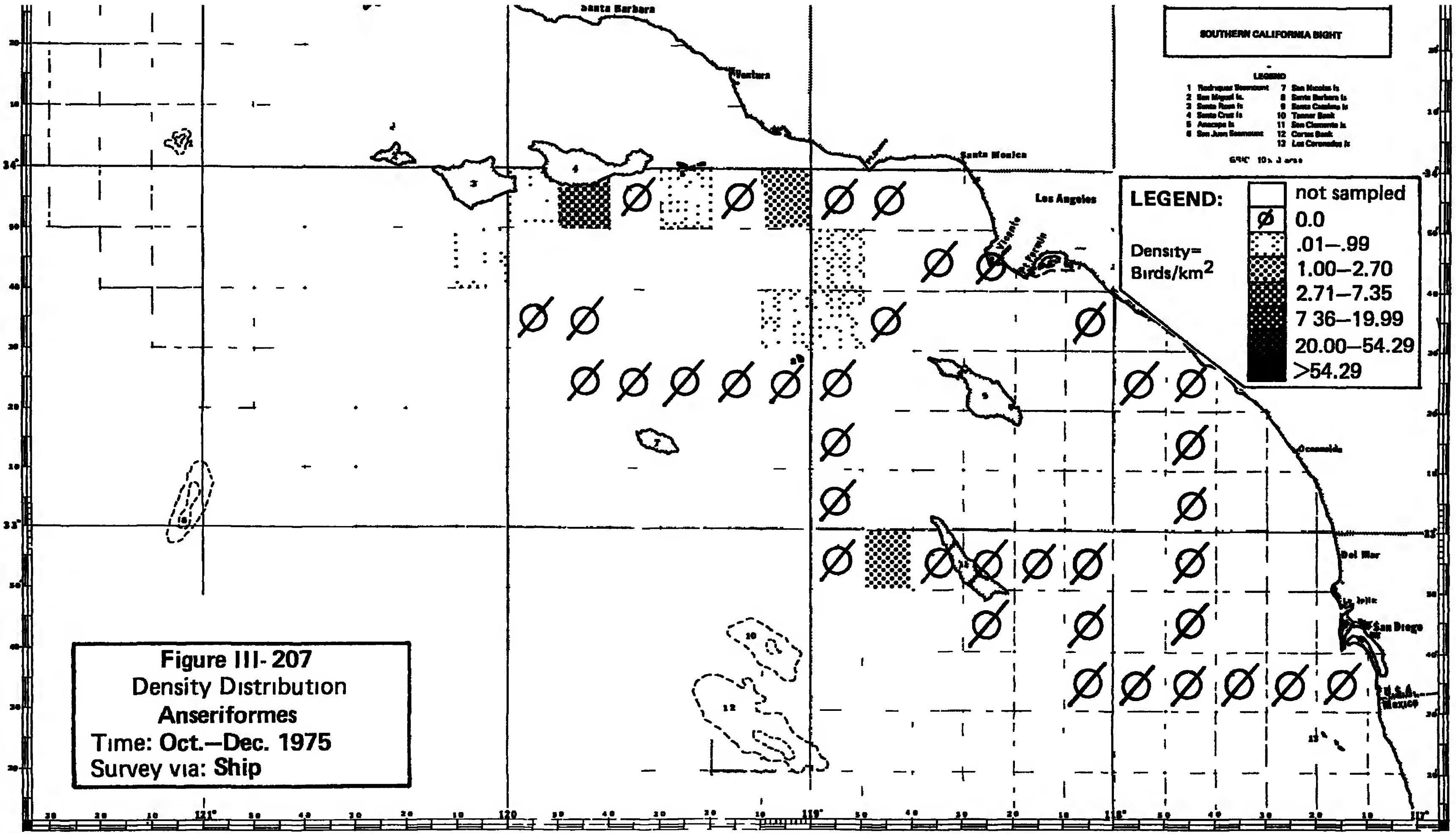

Figure III-207
Density Distribution
Anseriformes
Time: Oct.–Dec. 1975
Survey via: Ship

Table III-120 . Frequency of sightings of Ducks and Geese (Scoters, Mergansers, Brant). (total individuals) at selected southern California beaches April 1975 through March 1976. Dash indicates beach not surveyed. Numbers in parentheses are lengths of beach surveyed in km.

	Santa Cruz, North	Santa Cruz, West	Santa Cruz, South	McGrath S.B.	P.M.T.C., Pt. Mugu	Pt. Mugu S.B.	Dockweiler S.B.	Huntington S.B.	San Onofre S.B.	South Carlsbad S.B.	Silver Strand S.B.	Border Field S.B.	Totals
	(4.3)	(4.2)	(5.7)	(3.0)	(3.1)	(3.3)	(5.6)	(3.3)	(5.0)	(9.3)	(5.7)	(2.6)	(56.8)
11-27 April, 1975	2	0	0	0	-	21	-	-	8	-	0	0	31
11-24 May	0	0	8	0	-	0	100	0	0	6	0	0	114
13-19 June	0	0	0	0	-	2	0	0	0	0	0	1	3
11-18 July	0	0	4	0	6	0	0	0	0	0	0	0	10
1-7 August	0	0	0	0	2	0	0	0	0	0	0	0	2
11-18 September	0	0	0	1	16	0	0	0	0	0	-	-	17
15-18 October	0	0	0	.4	75	0	0	0	0	3	-	-	82
6-14 November	0	0	0	0	26	1	0	0	0	15	43	7	92
4-11 December	14	80	20	0	213	1	100	3	24	41	34	93	623
11-18 January, 1976	21	9	31	0	193	1	171	1	3	32	507	2	1032
16-24 February	42	46	26	0	160	14	149	8	3	0	4	2	568
11-22 March	15	17	31	1	72	0	162	4	5	14	19	5	408

Table III-121.

Frequency of sightings of Anseriformes (Scoters, Mergansers, Geese) (total individuals) on and near Channel Island beaches, January 1976 through March 1976. Numbers in parentheses refer to specific locations on Figures III-178 through -185. Dash indicates area not surveyed or survey incomplete.

Location / Date→ / Type→	Jan-Mar 76 Air (3)	Ship (3)							
SAN MIGUEL IS.									
Richardson Rk. (103)	0								
West (102,110-20,160,170)	20								
South (146-51)	85								
East (101,140-45)	24								
North (121-40)	28								
SANTA ROSA IS.									
West (611-12,625)	14								
South (620-24)	196								
East (618-19,629)	423								
North (610,613-17)	123								
SANTA CRUZ IS.									
West (641,658)	0								
South (650,653-56)	214								
East (649,651)	5								
North (640,643-48)	101								
ANACAPA IS. (660-80)	62								
SAN NICOLAS IS.									
Northwest (210-60)	0								
Southwest (203)	1								
Southeast (202)	0								
Northeast (201)	0								
SANTA BARBARA IS. (300-330)	3								
SANTA CATALINA IS.									
Northwest (506-07,515, 525-27)	2								
Southwest (503-05,529)	0								
South (502,523-24)	0								
East (501,509-11)	2								
Isthmus (508,521-522)	0								
SAN CLEMENTE IS.									
Northwest (409-11)	0								
West Central (406-08)	0								
Southwest 404-05)	0								
Pyramid Cove (402-03)	0								
East 401,412)	0								

Jaegers, Gulls and Terns (Charadriiformes: Stercorariidae and Laridae)

Twenty-two species of these two families were recorded during our 1975-76 surveys. One species (Western Gull) nests among the Channel Islands; but the rest occurred as migrants or winter residents.

April - June 1975. The overall density of gulls, terns and jaegers in southern California waters was moderate in April through June; the only major concentrations were found near Pt. Conception and in eastern San Pedro Channel (Fig. III-208). Birds were present in moderate numbers along the northern Santa Rosa-Cortés Ridge, near the four northern islands (Table III-122), and near San Nicolas and Santa Barbara Islands. Early in the period, substantial numbers of migratory Arctic Terns (Sterna paradisaea), Pomarine Jaegers (Stercorarius pomarinus), and Bonaparte's Gulls (Larus philadelphia) were seen (particularly in Santa Cruz Basin) in addition to the cosmopolitan Western Gull. By late May, the migrants became scarce and the overall density of this group mostly reflected that of the Western Gull, which was abundant locally near its Channel Island nesting colonies.

Residual summering populations of several migratory species (California and Ring-billed Gulls [L. californicus and L. delawarensis], for example) were found in June at mainland beaches from Ventura to San Diego Counties. Western Gulls were also common onshore (Tables III-123, 124, and 125).

July - September 1975. As in the preceding period, the overall density and distribution of gulls, terns and jaegers were predominantly functions of the resident Western Gull (Fig. III-209). These birds were most concentrated near mainland and island shores

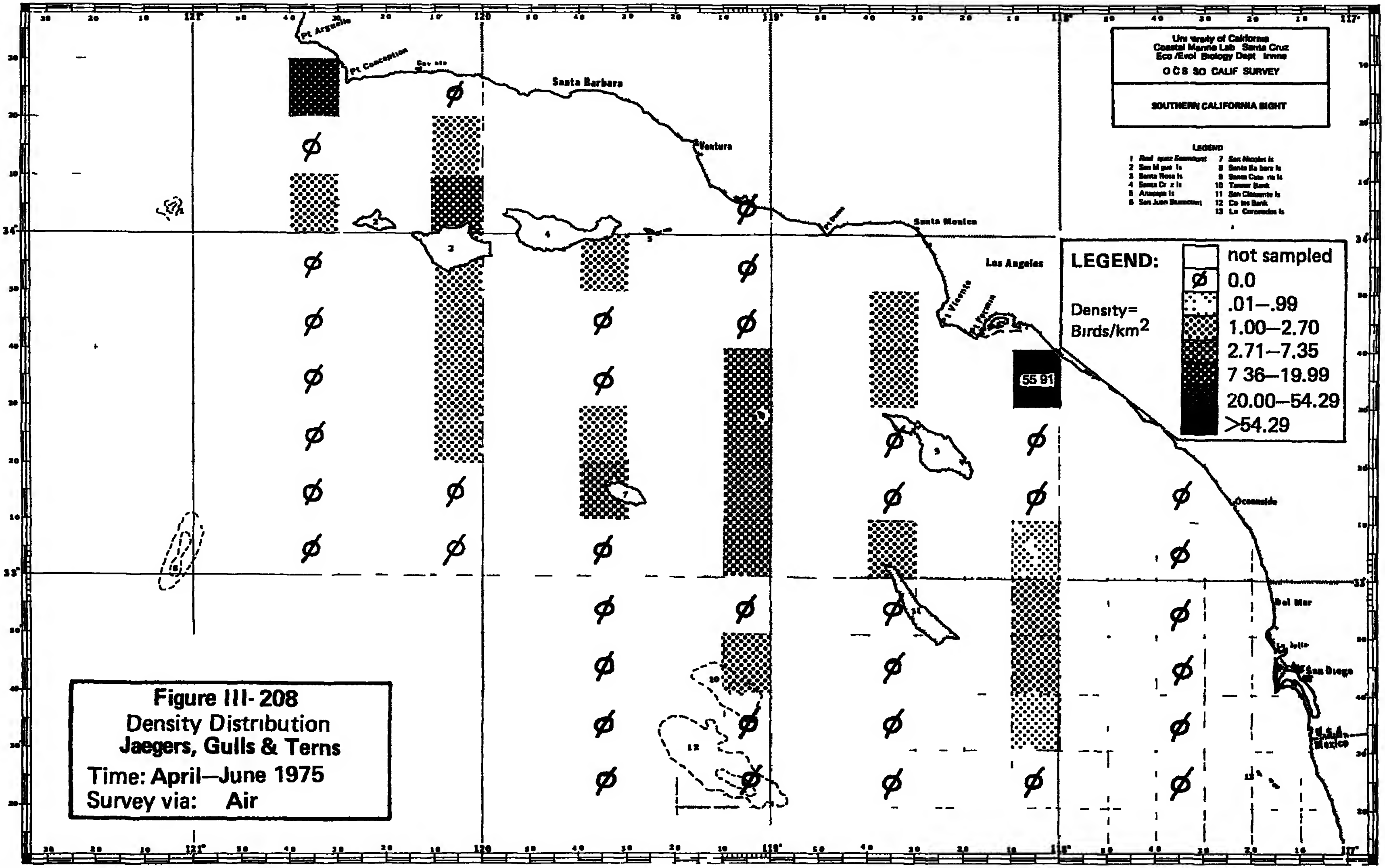

Figure III-208
Density Distribution
Jaegers, Gulls & Terns
Time: April—June 1975
Survey via: Air

Table III-122. Mean frequency (total individuals) of all Gulls, Terns, Jaegers on and near Channel Islands beaches by Quarter of the year April 1975 through March 1976. In the First and Last Quarters, counts are derived by averaging data from flights and inshore ship surveys. Numbers in parentheses following locations refer to specific areas indicated on Figures 178 through III-185. Dash indicates area not surveyed or survey incomplete. A = Air S = Ship.

Date→	Apr-Jun 75	Jul-Sep 75	Oct-Dec 75	Jan-Mar 76
Location Type→	A-2	A-1	A-2	A-3 S-3
SAN MIGUEL IS.				
Richardson Rk. (103)	25	12	3	46
West (102,110-20,160,170)	274	262	299	529
South (146-51)	45	83	20	76
East (101,140-45)	718	509	25	219
North (121-40)	15	14	51	94
SANTA ROSA IS.				
West (611-12,625)	0	291	234	200
South (620-24)	18	63	52	775
East (618-19,629)	114	96	56	758
North (610,613-17)	36	436	185	216
SANTA CRUZ IS.				
West (641,658)	35	63	255	81
South (650,653-56)	51	180	232	156
East (649,651)	63	139	4	51
North (640,643-48)	181	190	76	133
ANACAPA IS. (660-80)	-	-	-	2281
SAN NICOLAS IS.				
Northwest (210-60)	-	60	833	831
Southwest (203)	69	81	25	95
Southeast (202)	0	-	240	374
Northeast (201)	2	-	20	59
SANTA BARBARA IS.(300-330)	980	122	384	183
SANTA CATALINA IS.				
Northwest (506-07,515, 525-27)	28	35	49	365
Southwest (503-05,529)	93	43	85	357
South (502,523-24)	67	9	20	22
East (501,509-11)	44	31	8	25
Isthmus (508,521-522)	95	65	25	240
SAN CLEMENTE IS.				
Northwest (409-11)	105	136	87	100
West Central (406-08)	44	34	77	228
Southwest 404-05)	15	33	133	1
Pyramid Cove (402-03)	8	29	39	0
East 401,412)	20	0	-	3

(total individuals) at selected southern California beaches April 1975 through March 1976.
Dash indicates beach not surveyed. Numbers in parentheses are lengths of beach surveyed in km.

	Santa Cruz, North	Santa Cruz, West	Santa Cruz, South	McGrath S.B.	P.M.T.C., Pt. Mugu	Pt. Mugu S.B.	Dockweiler S.B.	Huntington S.B.	San Onofre S.B.	South Carlsbad S.B.	Silver Strand S.B.	Border Field S.B.	Totals
	(4.3)	(4.2)	(5.7)	(3.0)	(3.1)	(3.3)	(5.6)	(3.3)	(5.0)	(9.3)	(5.7)	(2.6)	(56.8)
11-27 April, 1975	0	0	5	0	-	0	-	-	0	-	0	0	5
11-24 May	0	0	0	1	-	0	40	190	0	0	0	0	231
13-19 June	0	0	0	0	-	0	13	240	0	0	0	2	255
11-18 July	0	0	0	2	0	0	55	195	0	0	2	0	254
1-7 August	0	0	0	3	0	0	23	105	1	0	0	0	132
11-18 September	0	0	0	0	0	0	188	130	6	0	-	-	324
15-18 October	0	0	0	14	1	0	186	40	3	0	-	-	244
6-14 November	87	47	3	381	1	0	72	0	6	1	8	12	618
4-11 December	500	0	168	110	42	3	7	58	0	8	1	256	1153
11-18 January, 1976	0	39	200	30	98	3	4	38	10	9	1	2175	2607
16-24 February	1	733	33	0	21	1	0	13	4	2	4	20	832
11-22 March	0	130	21	5	0	0	0	9	1	0	3	0	169

Table III-124 . Frequency of sightings of Ring-billed Gulls (total individuals) at selected southern California beaches April 1975 through March 1976. Dash indicates beach not surveyed. Numbers in parentheses are lengths of beach surveyed in km.

	Santa Cruz, North	Santa Cruz, West	Santa Cruz, South	McGrath S.B.	P.M.T.C., Pt. Mugu	Pt. Mugu S.B.	Dockweiler S.B.	Huntington S.B.	San Onofre S.B.	South Carlsbad S.B.	Silver Strand S.B.	Border Field S.B.	Totals
	(4.3)	(4.2)	(5.7)	(3.0)	(3.1)	(3.3)	(5.6)	(3.3)	(5.0)	(9.3)	(5.7)	(2.6)	(56.8)
11-27 April, 1975	3	0	3	1	-	4	-	-	5	-	4	0	20
11-24 May	0	0	0	0	-	0	2	0	0	0	0	0	2
13-19 June	0	0	0	0	-	0	1	30	0	0	11	0	42
11-18 July	0	0	0	1	4	0	21	145	0	3	5	0	179
1-7 August	0	0	0	0	6	0	27	0	1	0	5	0	39
11-18 September	0	0	0	1	10	10	57	45	1	18	-	-	142
15-18 October	0	0	0	0	25	1	56	34	1	18	-	-	135
6-14 November	0	0	0	184	288	0	24	65	24	22	367	58	1032
4-11 December	0	0	0	12	674	0	35	59	24	0	6	67	877
11-18 January, 1976	0	0	0	30	686	3	65	17	50	50	1	217	1119
16-24 February	0	0	0	1	142	4	20	15	16	277	10	22	507
11-22 March	0	0	0	2	6	16	23	4	3	21	4	14	93

(total individuals) at selected southern California beaches April 1975 through March 1976. Dash indicates beach not surveyed. Numbers in parentheses are lengths of beach surveyed in km.

	Santa Cruz, North	Santa Cruz, West	Santa Cruz, South	McGrath S.B.	P.M.T.C., Pt. Mugu	Pt. Mugu S.B.	Dockweiler S.B.	Huntington S.B.	San Onofre S.B.	South Carlsbad S.B.	Silver Strand S.B.	Border Field S.B.	Totals
	(4.3)	(4.2)	(5.7)	(3.0)	(3.1)	(3.3)	(5.6)	(3.3)	(5.0)	(9.3)	(5.7)	(2.6)	(56.8)
11-27 April, 1975	1	500	120	10	-	6	-	-	0	-	2	0	639
11-24 May	48	361	1	131	-	0	0	15	0	4	45	50	645
13-19 June	58	139	19	610	-	43	58	50	8	6	176	49	1216
11-18 July	14	229	89	446	20	26	49	195	28	1	84	1	1182
1-7 August	85	189	12	200	31	15	16	0	0	13	12	140	713
11-18 September	54	73	56	1444	63	44	6	15	12	21	-	-	1788
15-18 October	20	19	6	821	75	44	0	1	25	10	-	-	1021
6-14 November	49	114	84	1054	123	2	0	3	10	3	1	84	1527
4-11 December	17	60	89	160	300	7	1	0	0	23	4	406	1067
11-18 January, 1976	12	56	72	918	92	6	0	0	10	35	1	102	1304
16-24 February	24	118	27	208	36	3	2	0	17	51	6	80	660
11-22 March	14	47	9	2337	51	17	4	0	6	13	2	37	2537

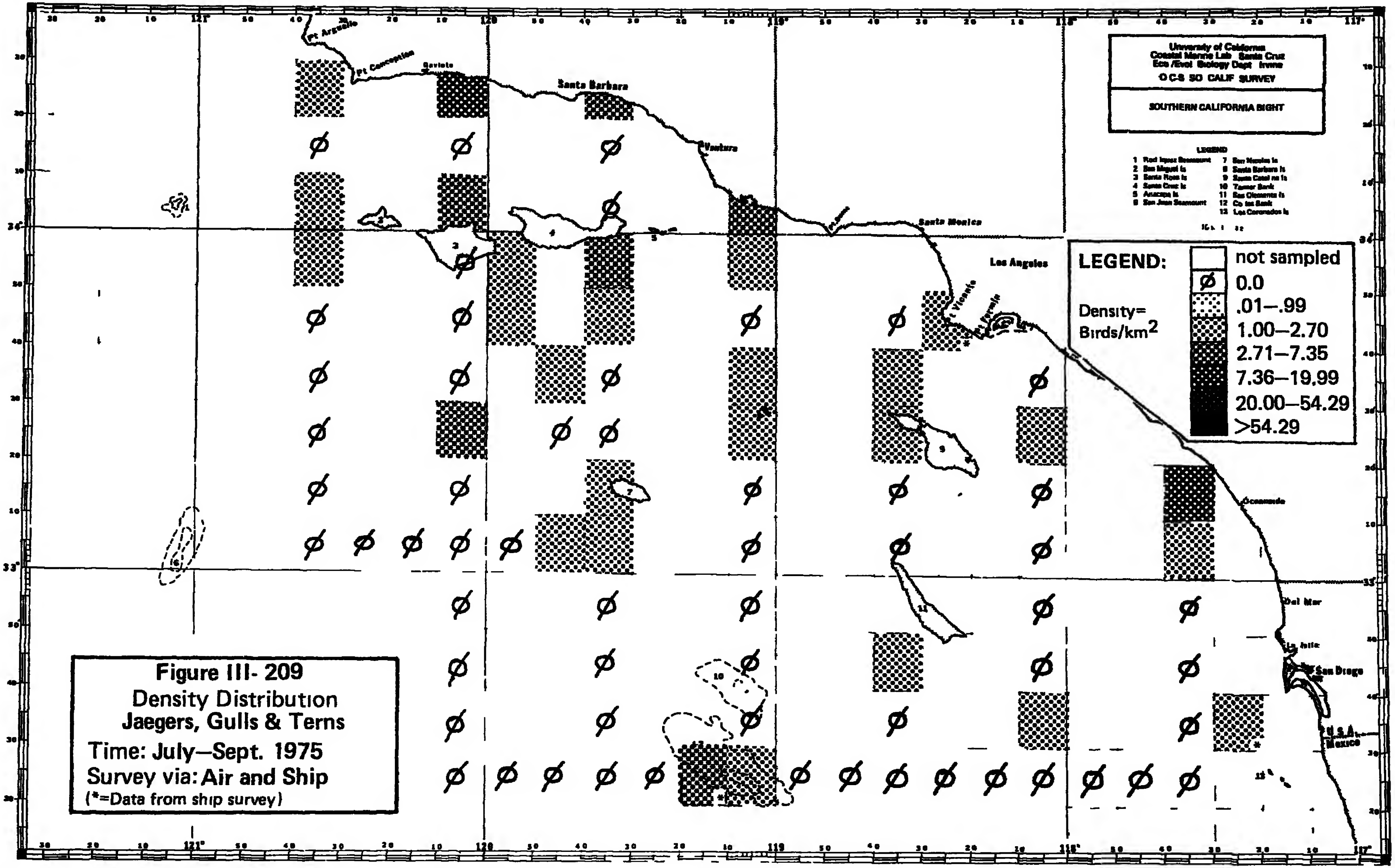

Figure III- 209
Density Distribution
Jaegers, Gulls & Terns
Time: July—Sept. 1975
Survey via: Air and Ship
(*=Data from ship survey)

(Table III-122), in waters overlying the northern Santa Rosa-Cortés Ridge, and near Cortés Bank. In the course of two September cruises we found Western Gulls, Pomarine Jaegers, and Arctic Terns rather evenly distributed in low to moderate densities in deep waters (greater than 1000 m) west of San Miguel and San Nicolas islands, indicating that post-breeding dispersal of the former and southward migration of the latter two species was under way.

Summering populations of several species of larids were present on mainland beaches included in our live bird counts; the numbers of three of these (Heermann's Gull [Larus heermanni], Caspian and Elegant Terns [Hydroprogne caspia and Sterna elegans]) increased or reached their yearly highs in this period (Tables III-126, 127, 128).

October - December 1975. Total numbers of gulls, terns and jaegers increased dramatically through the fall months. To the ranks of the resident Western Gull were added wintering populations of Pomarine Jaegers, Herring, California, Ring-billed and Bonaparte's Gulls, both near shore and in open-ocean waters. Particularly dense aggregations were noted in eastern Santa Barbara Channel, Santa Monica Bay, and San Pedro Channel (the latter two areas harbored many thousands of Bonaparte's Gulls). With the exception of the Gulf of Santa Catalina (where densities were low) we found moderate densities elsewhere within 125 km of the mainland (Fig. III-210). These birds were not present in appreciable numbers west of the continental slope (Patton Escarpment), though moderately dense concentrations were found at Cortés Bank in October.

	Santa Cruz, North	Santa Cruz, West	Santa Cruz, South	McGrath S.B.	P.M.T.C., Pt. Mugu	Pt. Mugu S.B.	Dockweiler S.B.	Huntington S.B.	San Onofre S.B.	South Carlsbad S.B.	Silver Strand S.B.	Border Field S.B.	Totals
	(4.3)	(4.2)	(5.7)	(3.0)	(3.1)	(3.3)	(5.6)	(3.3)	(5.0)	(9.3)	(5.7)	(2.6)	(56.8)
11-27 April, 1975		None	recorded.		-		-	-		-			0
11-24 May	1	0	0	0	-	0	0	0	0	0	0	0	1
13-19 June	0	0	0	0	-	6	82	351	1	0	0	7	447
11-18 July	6	85	8	108	108	6	173	140	535	12	9	0	1190
1-7 August	95	135	6	45	250	24	191	290	257	16	7	11	1327
11-18 September	70	1	1	69	106	114	663	68	163	13	-	-	1268
15-18 October	25	0	0	26	22	8	114	25	88	0	-	-	308
6-14 November	17	5	11	0	64	8	166	23	10	10	32	6	351
4-11 December	44	0	0	40	22	0	294	9	0	1	0	0	410
11-18 January, 1976	0	0	0	0	0	0	2	7	1	0	0	0	10
16-24 February	0	0	1	1	0	0	2	0	0	0	0	0	4
11-22 March		None	recorded.										0

(total individuals) at selected southern California beaches April 1975 through March 1976.
Dash indicates beach not surveyed. Numbers in parentheses are lengths of beach surveyed in km.

	Santa Cruz, North	Santa Cruz, West	Santa Cruz, South	McGrath S.B.	P.M.T.C., Pt. Mugu	Pt. Mugu S.B.	Dockweiler S.B.	Huntington S.B.	San Onofre S.B.	South Carlsbad S.B.	Silver Strand S.B.	Border Field S.B.	Totals
	(4.3)	(4.2)	(5.7)	(3.0)	(3.1)	(3.3)	(5.6)	(3.3)	(5.0)	(9.3)	(5.7)	(2.6)	(56.8)
11-27 April, 1975		None	recorded.										
11-24 May		None	recorded.										
13-19 June	0	0	0	0	-	0	0	0	0	0	5	2	7
11-18 July	0	0	0	0	0	0	0	0	0	0	4	200	204
1-7 August	0	0	0	0	0	0	0	0	0	0	0	120	120
11-18 September	0	0	0	4	4	0	0	7	2	0	-	-	17
15-18 October	0	0	0	0	17	0	12	41	0	0	-	-	70
6-14 November	0	0	0	0	0	0	5	0	2	3	0	0	10
4-11 December		None	recorded.										
11-18 January, 1976		None	recorded.										
16-24 February		None	recorded.										
11-22 March		None	recorded.										

Table III-128 . Frequency of sightings of Caspian Terns (total individuals) at selected southern California beaches April 1975 through March 1976. Dash indicates beach not surveyed. Numbers in parentheses are lengths of beach surveyed in km.

	Santa Cruz, North	Santa Cruz, West	Santa Cruz, South	McGrath S.B.	P.M.T.C., Pt. Mugu	Pt. Mugu S.B.	Dockweiler S.B.	Huntington S.B.	San Onofre S.B.	South Carlsbad S.B.	Silver Strand S.B.	Border Field S.B.	Totals
	(4.3)	(4.2)	(5.7)	(3.0)	(3.1)	(3.3)	(5.6)	(3.3)	(5.0)	(9.3)	(5.7)	(2.6)	(56.8)
11-27 April, 1975	0	0	0	0	-	0	-	-	0	-	1	2	3
11-24 May	0	0	0	0	-	0	0	0	0	0	2	0	2
13-19 June	0	0	0	0	-	0	0	0	0	0	3	1	4
11-18 July	0	0	0	17	3	0	0	0	0	0	8	0	28
1-7 August	0	0	0	0	4	0	0	0	0	0	1	1	6
11-18 September	1	0	0	19	99	1	0	1	0	0	-	-	121
15-18 October	0	0	0	0	5	0	0	0	0	0	-	-	5
6-14 November	0	0	0	0	0	0	0	0	0	0	0	0	0
4-11 December	0	0	0	0	1	0	0	4	0	0	0	0	4
11-18 January, 1976	0	0	0	0	23	0	0	0	0	0	0	0	23
16-24 February	0	0	0	0	24	0	0	0	0	0	0	0	24
11-22 March	0	0	0	0	15	0	0	0	0	0	0	19	34

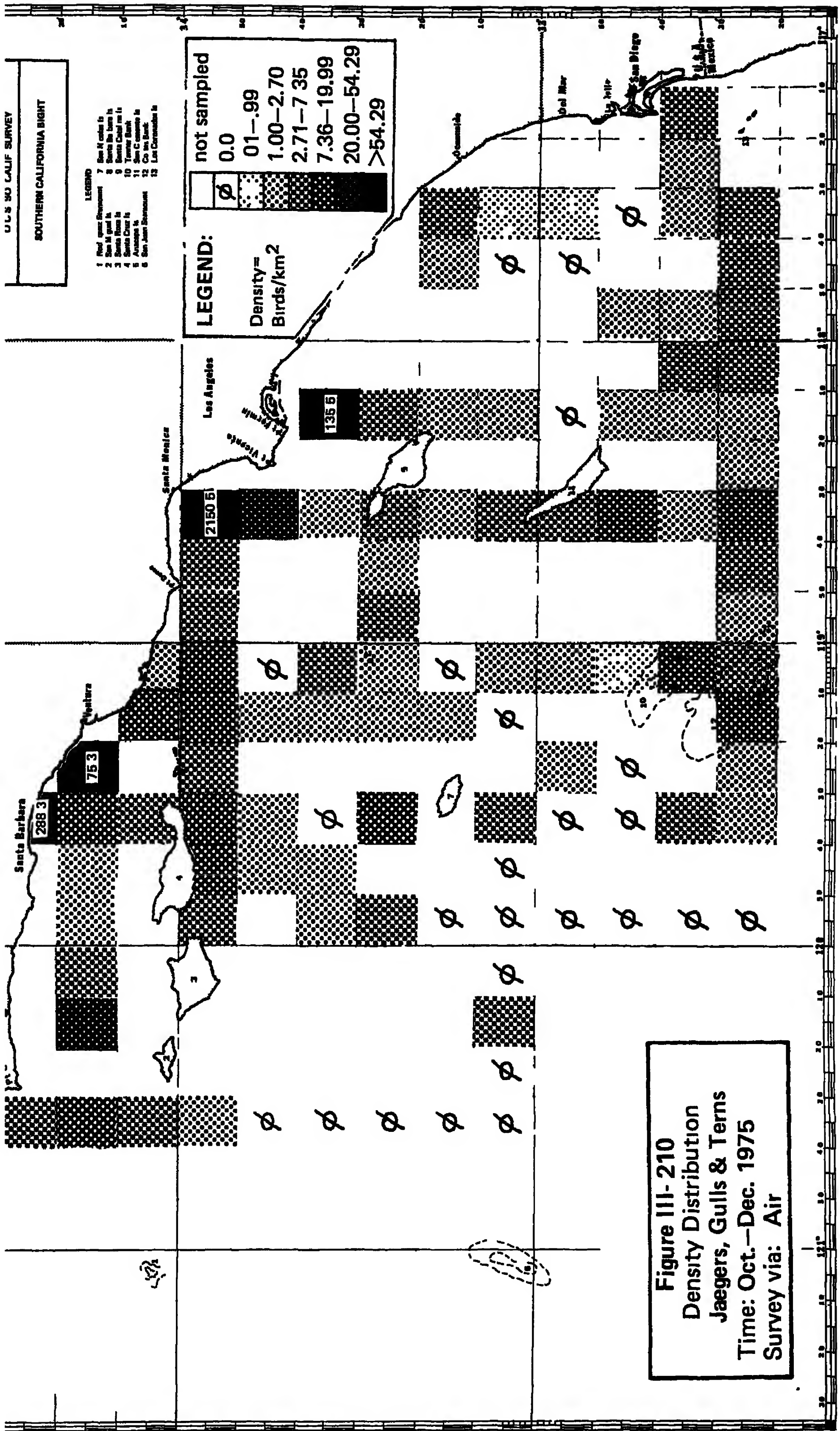

Figure III-210
Density Distribution
Jaegers, Gulls & Terns
Time: Oct.–Dec. 1975
Survey via: Air

Populations swelled near Channel Is. shores (Table III-122), reflecting the influx of California Gulls in open-ocean waters and roosting of resident Western Gulls. Elegant, Royal (Sterna maximus), Caspian and Forster's Terns (Sterna forsteri) were found commonly at mainland beaches, though their contribution to the overall numbers of this group was relatively small.

January - March 1976. By far the largest numbers of gulls and jaegers were recorded in the study area in the winter months. Bonaparte's Gulls, which had contributed substantially to the total density of larids in offshore areas in the autumn, withdrew to several localities along the mainland (Santa Monica Bay, San Pedro Channel, Newport Bay, San Diego Bay), where they overwintered. This species was replaced offshore by tremendous numbers of California and Western Gulls and Black-legged Kittiwakes (Rissa tridactyla). 1975-76 was a so-called "flight year" for the latter species, indicating that large numbers could be observed relatively close to shore rather than remaining to the north or west of the study area through the winter (as is apparently the case in many years).

Gulls were particularly abundant in shallow water areas (less than 200 m) in eastern Santa Barbara Channel, from 5 to 75 km south-southeast of Santa Rosa Is., 25 km south of San Nicolas Is. (229 birds/km^2 observed in January), near Cortés Bank, and in San Pedro Channel (Fig. III-211). Birds among the aggregations in Santa Barbara Channel, near Santa Catalina Is., and along the northern Santa Rosa-Cortés Ridge were seen to prey upon squid (species unknown), which perhaps were spawning in these areas.

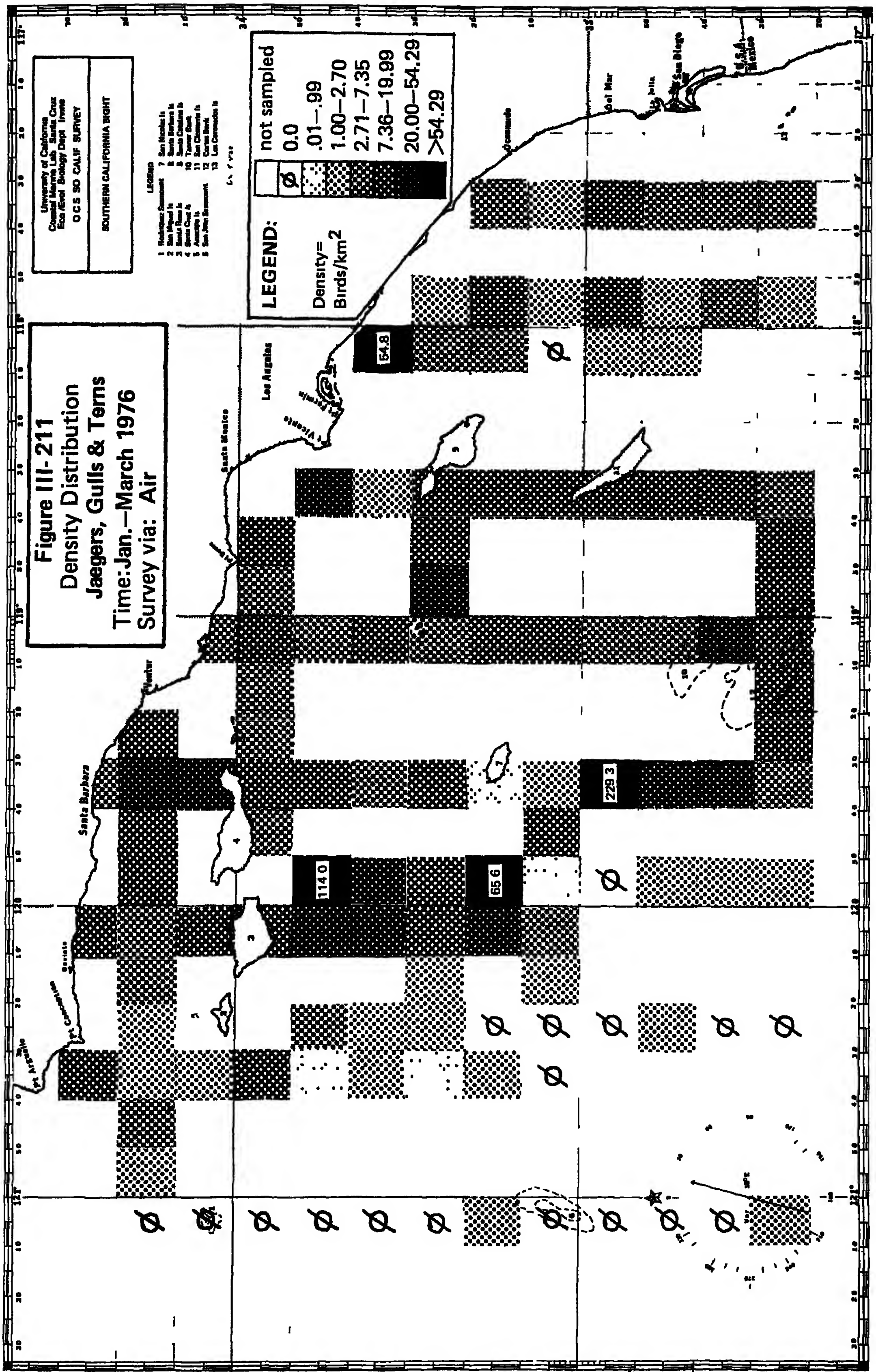

Figure III-211
Density Distribution
Jaegers, Gulls & Terns
Time: Jan.—March 1976
Survey via: Air

These feeding groups also included several species of small cetaceans, California sea lions, and other bird species.

The waters west of the Patton Escarpment were not densely populated by gulls and jaegers in winter. In contrast, the Gulf of Santa Catalina harbored more of these birds than in any other season, probably reflecting breakdown of horizontal temperature gradients through the study area and more homogeneous distribution of seabird foods in this, as compared with other seasons.

Very large numbers of gulls were found around Channel Is. shores and on mainland beaches (Table III-122). Total numbers of terns were relatively small and were localized at a few mainland sites.

In March we detected area-wide declines in populations of Bonaparte's, Herring, and California Gulls, though those of the Western Gull and Black-legged Kittiwake remained high.

Auks (Charadriiformes: Alcidae)

We recorded nine species of alcids in southern California waters, of which three nested on the Channel Is. The others occurred primarily as winter residents and contributed substantially to overall avian density at sea in several sectors of the study area in January through March.

April - June 1975. Alcids were found scattered in low to moderate densities offshore during this period, with high concentrations recorded near the breeding islands of San Miguel and Santa Barbara (Fig. III-212). Alcid densities reached 39 birds per km^2 near San Miguel Is., where large numbers of Cassin's Auklets were found, and 21 per km^2 in the vicinity of Santa Barbara Is.,

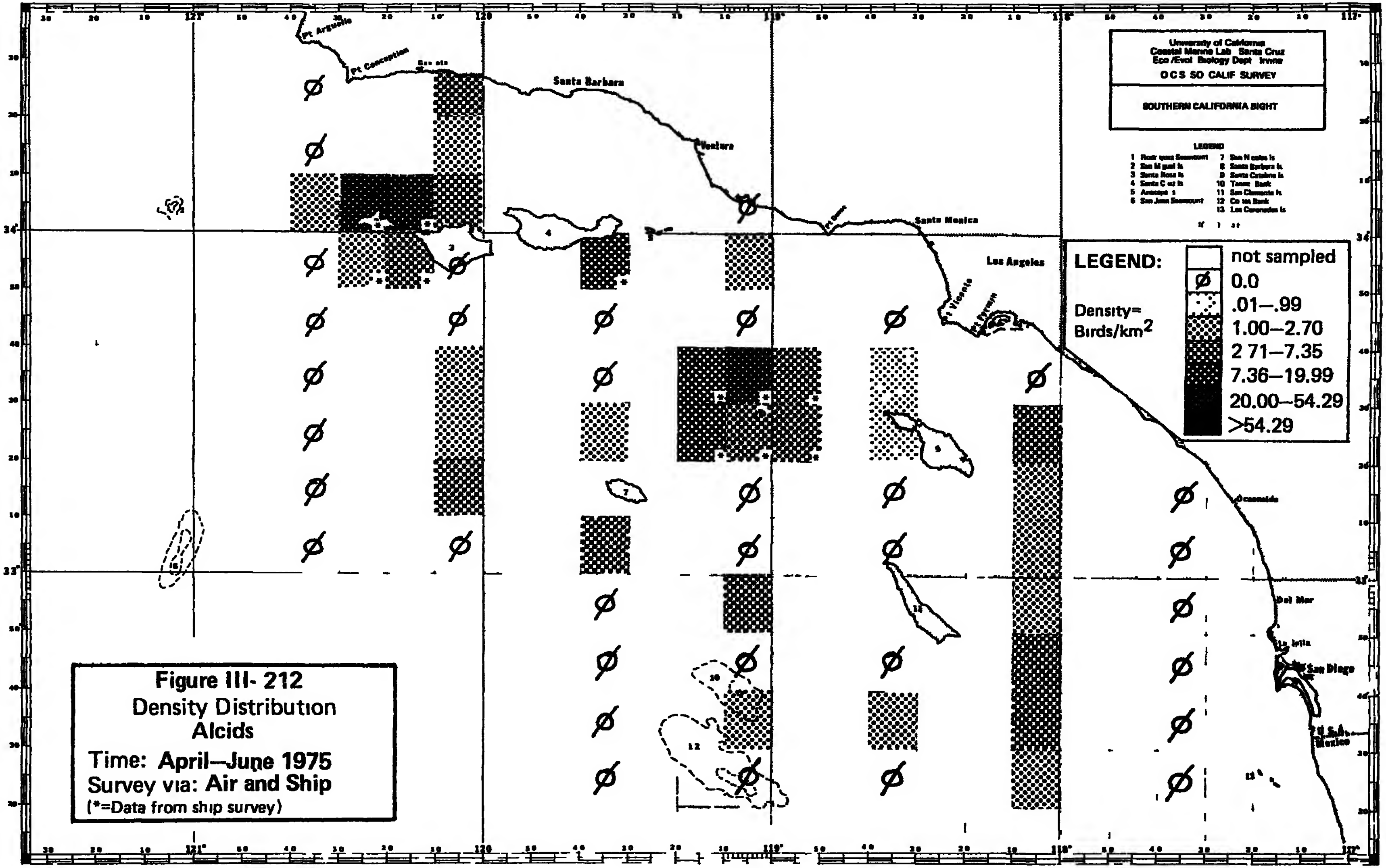

Figure III- 212
Density Distribution
Alcids
Time: April–June 1975
Survey via: Air and Ship
(*=Data from ship survey)

comprised mainly of Xantus' Murrelets. Offshore, alcids (mostly Xantus' and unidentified Murrelets) were found in moderate numbers in Santa Barbara Channel, south of Santa Rosa Is. to 33°00'N, in Anacapa Passage, near Tanner, Cortés and Fortymile Banks, and east of San Clemente and Santa Catalina islands. Pigeon Guillemots were recorded inshore at northern islands breeding locations. Moderate densities of Horned Puffins (Fratercula corniculata) were observed at the south end of San Miguel Passage, and between Santa Rosa and Santa Barbara islands during May ship surveys. Four Tufted Puffins (Linda cirrhata) were encountered during this period, all in the northwest quadrant of the study area.

July - September 1975. Alcid densities in the Bight appeared to decline slightly during this period although concentrations remained near the two major breeding islands (San Miguel and Santa Barbara) (Fig. III-213), especially in July. Densities reached 45.71/km^2 near San Miguel Is., and 2.70/km^2 near Santa Barbara Is. (Fig. III-213). Cassin's Auklets and Xantus' Murrelets again accounted for most sightings. Offshore, low to moderate densities were recorded at both end of Santa Barbara Channel and immediately south of Santa Rosa Island. Low numbers were encountered between Santa Rosa and Santa Barbara islands, north of San Nicolas Is., off Pt. Vicente, between Santa Catalina and San Clemente islands, near Tanner, Cortés and Fortymile Banks, and east of San Clemente Island. Pigeon Guillemots remained near their northern islands breeding sites until August, after which none were recorded until February.

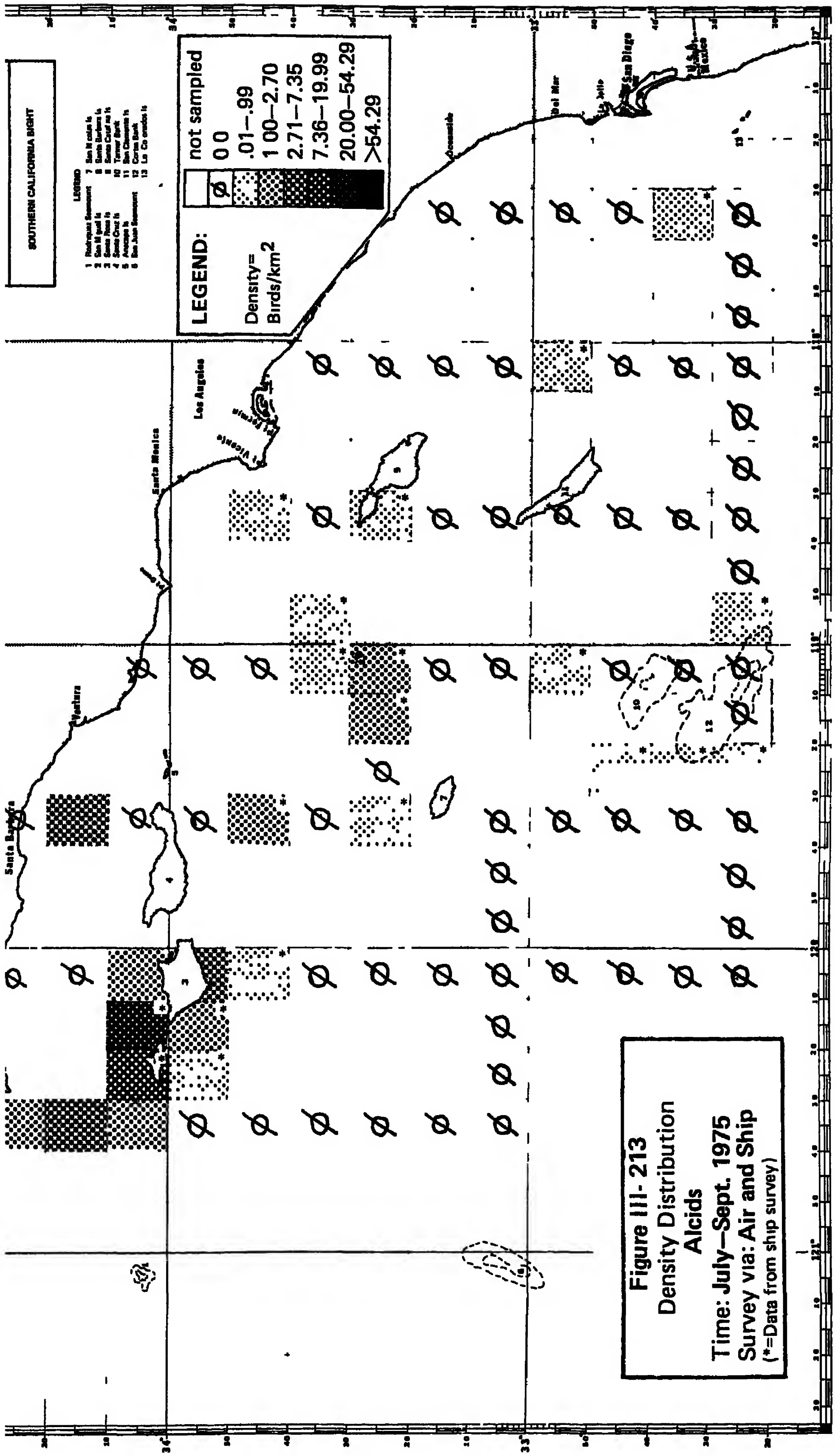

Figure III- 213
Density Distribution
Alcids
Time: July–Sept. 1975
Survey via: Air and Ship
(*=Data from ship survey)

October - December 1975. The pattern of alcid distribution changed during this period, reflecting the post-breeding dispersal of local residents and an influx of Rhinoceros Auklets (*Cerorhinca monocerata*) from the north. Moderate densities were recorded offshore (generally east of the Santa Rosa-Cortés Ridge) and reduced densities around the two breeding sites (San Miguel and Santa Barbara Islands). The highest were found at San Miguel Passage (9.68/km^2) and near Cortés Bank (14.33/km^2). Significant numbers of these birds also were recorded from the entire Santa Rosa-Cortés Ridge, along the south side of the northern island chain, in Santa Monica Bay, near Tanner and Fortymile Banks, and offshore of San Diego. Rhinoceros Auklets made up the bulk of the sightings, reflecting their arrival in the Bight in December. Cassin's Auklets and Xantus' Murrelets contributed moderate numbers to the total, especially along the south sides of Santa Cruz and Anacapa Islands, and along the Santa Rosa-Cortés Ridge (Fig.III-214).

January - March 1976. Alcid densities peaked throughout the Bight during this period of our study. These birds were particularly ubiquitous west of 119°00'W, congregating near the banks, islands, and island passages (Fig. III-215). Moderate to high densities were recorded out to Rodriguez Seamount. Rhinoceros and Cassin's Auklets, Common Murres and Xantus' Murrelets were the most abundant species encountered during this period. Common Murres were again encountered in very high densities in Santa Barbara Channel, especially toward the eastern end. Rhinoceros Auklets were found in moderate densities throughout the Bight, with particular

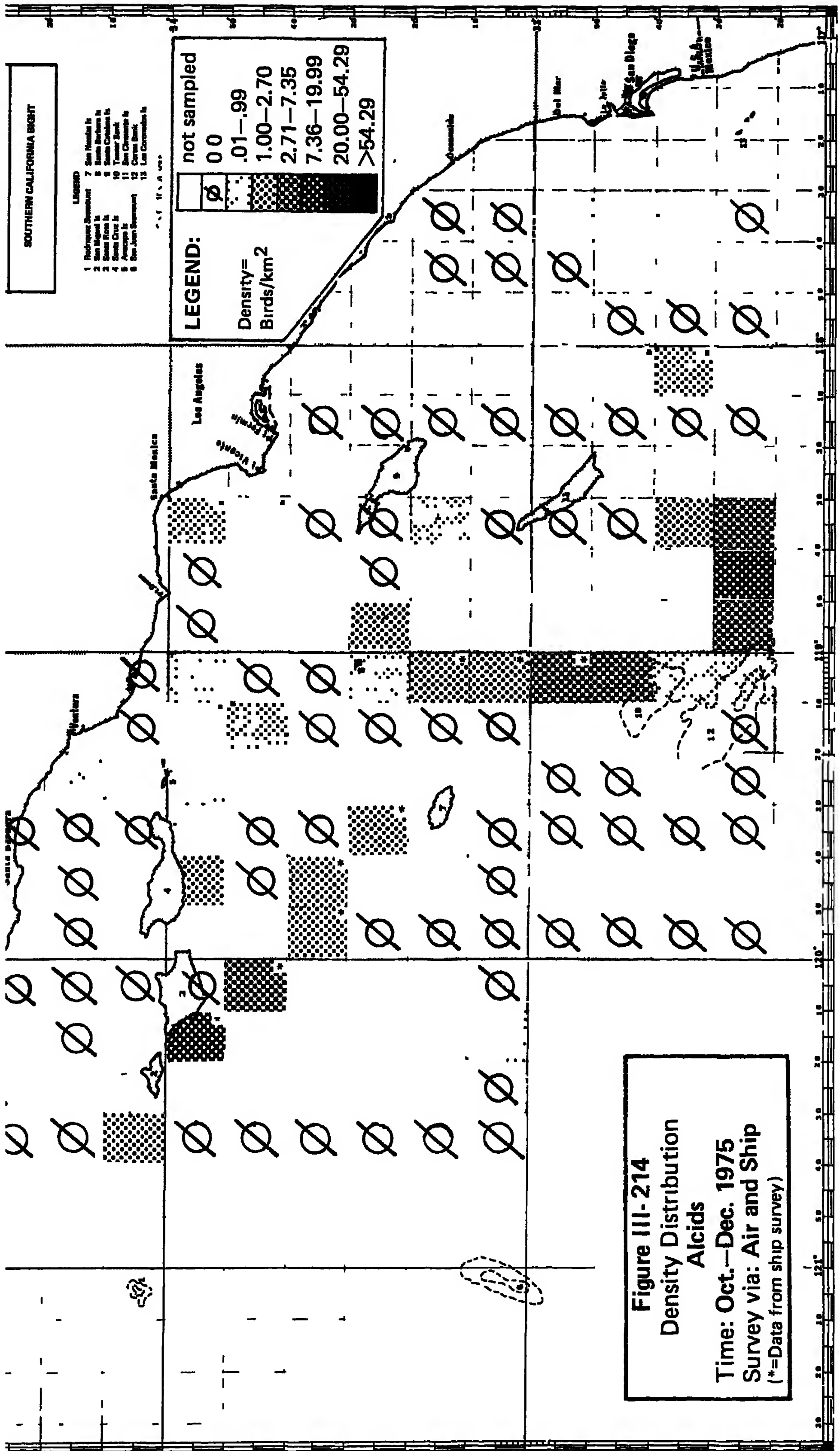

Figure III-214
Density Distribution
Alcids
Time: Oct.—Dec. 1975
Survey via: Air and Ship
(*=Data from ship survey)

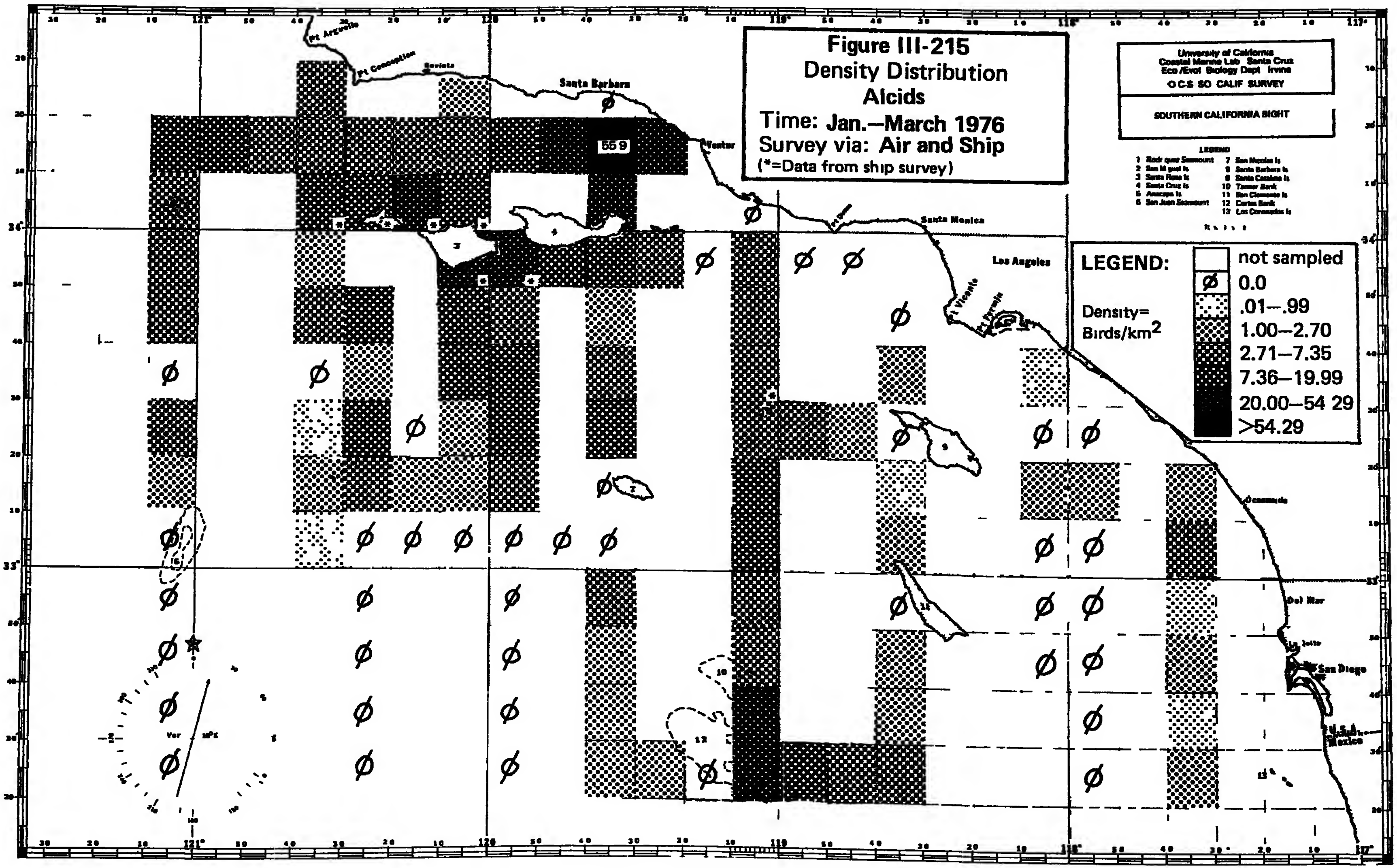

Figure III-215
Density Distribution
Alcids
Time: Jan.—March 1976
Survey via: Air and Ship
(*=Data from ship survey)

concentrations occurring at Cortés Bank. Very high densities of Rhinoceros Auklets were found in the northern island passages in March, as they apparently massed for the northern migration. Cassin's Auklets were almost as widely distributed, but concentrated to the west, particularly near the San Miguel Is. breeding colonies. Xantus' Murrelets tended to be found near Santa Barbara Is., particularly during March, although moderate numbers were seen along the Santa Rosa-Cortés Ridge in January. Several Tufted Puffins were recorded north and west of San Miguel Is. out to Rodriguez Seamount in January.

b. Synoptic species accounts

Common Loon (*Gavia immer*)

Spring migration was underway when this study began in mid-April. Our few April and May records were probably of late-departing birds. Common Loons went unrecorded through the summer and early fall (June - September). The first fall record was in late October, after which birds were present in small numbers through March 1976. During the late autumn and winter months, the birds appeared to be sedentary and remained inshore near the mainland coast and the islands. No actual migration data were obtained this year.

Arctic Loon (*Gavia arctica*)

Spring migration was underway when this study began in mid-April. Most of the loons observed in April and May were either part of northbound flows or offshore groups. By June, the records had dropped off considerably, and through September only scattered individuals and small flocks were observed. It seems probable that at least some birds summered in southern California. By November, large numbers of Arctic Loons were observed throughout the study area. December counts were low, but by January they had concentrated around the northern islands and in Santa Barbara Channel. Numbers there remained constant in February and increased in March.

Our first year's data support the contention that Arctic Loons are the most pelagic and the most abundant loon species in southern California. Only scattered individuals were observed along the mainland coast during the year except for occasional migratory flocks. Arctic Loons were most abundant and widespread in the Bight (especially

offshore) during peak periods of migration (March - May and October - November). In winter, numbers were reduced and the birds were primarily restricted to the protected inshore waters of islands and Santa Barbara Channel.

Red-throated Loon (*Gavia stellata*)

Spring migration was already in progress when this study began in mid-April, 1975. Our few spring records were probably of late-departing birds. The last Red-throated Loon record was on 13 June. This species went unrecorded through the summer and early fall. Birds were present from 10 November through the remainder of the study period. Red-throated Loons were numerically the dominant loon species inshore along the mainland coast in mid-winter, but with the exception of some nearshore island records, they were virtually absent offshore. These data are consistent with the historical record.

Red-necked Grebe (*Podiceps grisegena*)

A single Red-necked Grebe was observed and photographed in the company of Western Grebes at Port Hueneme on 19 and 22 March 1976.

Horned Grebe (*Podiceps auritus*)

Horned Grebes were unrecorded in the Southern California Bight from late spring through fall (April through November). Small numbers arrived along the mainland coast in early December and were present there through the remainder of the study period. They were also present in small numbers (maximum, 15 birds) around the northern islands through March and went unrecorded around the other islands and offshore.

Eared Grebe (*Podiceps nigricollis*)

Some Eared Grebes had probably already moved inland when our

study began in mid-April though many remained around the northern islands. By May only a few stragglers were left on marine waters. No Eared Grebes were known to summer in the Southern California Bight in 1975. The first fall birds arrived in October, and small numbers were present near the mainland through January. Offshore records were scarce in December through February, and absent in other months. By mid-February, large numbers had concentrated around the northern islands. Presumably due to a movement to inland nesting sites numbers there were reduced by March. This species greatly outnumbered other grebes in the waters of Santa Barbara Channel and near the northern islands, constituting a significant portion of the nearshore avifauna of these areas.

Western Grebe (Aechmophorus occidentalis)

Migration north was in progress when this study began in mid-April. Western Grebes were present along the mainland coast in gradually diminishing numbers through mid-June. They went unrecorded until mid-September, but the June birds may have been summering locally. Numbers steadily increased along the coast from October through March; this was the most abundant grebe along our beach census areas in winter 1976. This species was not recorded around the islands until October, after which small numbers were observed around the northern islands through March. They were absent offshore until December and scarce from then through March. None were recorded more than 25 km from land.

Black-footed Albatross (Diomedea nigripes)

Fifteen Black-footed Albatross were observed in the study

area in 1975-76, 13 in September and one each in October and January. Nearly all of these were in the vicinity of Cortés and Tanner Banks and none were seen closer than 80 km from the mainland.

Laysan Albatross (*Diomedea immutabilis*)

We observed one Laysan Albatross on 8 January 1976. It was seen on the water at Cortés Bank in the company of three California Gulls (*Larus californicus*), two Western Gulls (*L. occidentalis*) and three Northern Fulmars (*Fulmarus glacialis*). The birds were apparently feeding on the jellyfish *Pelagia* sp.

Cape Petrel (*Daption capense*)

What was probably a Cape Petrel was seen during our studies this year. It was observed following the survey vessel, flying about 6 m off the water, 48 km west of Del Mar, San Diego County, on 30 August 1975. The description of this bird taken in the field, though incomplete, strongly suggests this species.

Northern Fulmar (*Fulmarus glacialis*)

The winter of 1975-76 was apparently the largest flight year for Northern Fulmars in southern California in at least the last decade. Numbers of fulmars were low in November, with only scattered sightings of single individuals. By December they were widespread, but still not numerous, and peak densities of 5 to 10 birds/km^2 were recorded in January and February. Most observations of this species came from the northern Patton Escarpment, Santa Barbara Channel (March) and northern islands chain, Tanner, Cortes and Fortymile Banks, and near the Coronado Escarpment.

We detected no significant temporal or geographic pattern to the distribution of birds of the three discernible color phases. Dark-phase birds predominated throughout the winter in all areas

we sampled (76% of 316 sightings for which color was recorded).

Pink-footed Shearwater (*Puffinus creatopus*)

Pink-footed Shearwaters were the second most common shearwater in the Southern California Bight, after the Sooty Shearwater. The species exhibited a cosmopolitan distribution for most of the year, reaching highest numbers from June to September. Birds were encountered most frequently around the northern Channel Islands, along the Santa Rosa-Cortés Ridge, in Santa Barbara Channel, in San Nicolas Basin and in the area east of longitude 118° W at the latitude of the U.S.-Mexican border. While Sooty Shearwaters tended to move northwest toward San Miguel Is. as the summer advanced, Pink-footed Shearwaters showed no such pattern. Isolated sightings continued throughout the winter.

Flesh-footed Shearwater (*Puffinus carneipes*)

We have one record of a Flesh-footed Shearwater since April 1975. It was seen over the open sea near the eastern escarpment of the Santa Rosa-Cortés Ridge, about midway between Santa Rosa and San Nicolas Islands on 19 June 1975.

New Zealand Shearwater (*Puffinus bulleri*)

This species was seen on only two dates, 16 May and 9 September. The May record is exceptionally unusual and may be the first spring record for California. On 9 September a total of 4-7 individuals were seen near San Miguel Is.

Sooty Shearwater (*Puffinus griseus*)

Birds of this species were abundant in the Southern California Bight from April to September. The greatest concentrations were centered around the northern Channel Islands and in the waters overlying

the northern section of the Santa Rosa-Cortés Ridge. In April - May, they were also common in San Pedro Channel and elsewhere east of longitude 118°30' W, but densities in this region declined as the summer progressed.

It is, of course, too early to draw any conclusions from the distributional patterns we observed this first year. However, our data from September do tend to support Pyle and DeLong's idea (1968 ms) that birds from both north and south of the study area mass to the north and west of Santa Rosa and San Miguel Islands before beginning their return to breeding stations in the southern hemisphere.

This year's behavioral data, when considered with the consistently elevated densities of Sooty Shearwaters throughout the summer around the northern Channel Islands, provide intriguing insights regarding the spring and summer status of this species in southern California. It is possible that overlap between presumed late northward migrants and early southbound birds is responsible for the large numbers of shearwaters in southern California during July and August, but it is equally likely that many birds spend their summer feeding in the rich waters just west of San Miguel Is. and never pass north of Pt. Conception. Broader distribution and increased numbers during spring and summer as compared to the fall may indicate the species remains closer inshore during the season of cold currents and strong upwelling and moves farther offshore with the development of the warmer Davidson Countercurrent (cf. Pyle and DeLong 1968 ms). This pattern would certainly uphold the contention that the Sooty Shearwater is primarily a cold-water species. In the fall, birds which have summered here may join with migrating

birds from more northern waters and from elsewhere in southern California, producing the September massing and westbound streams noted by Pyle and DeLong (1968 ms). We found no evidence for a second, late fall wave of migrants in 1975.

Short-tailed Shearwater (Puffinus tenuirostris)

Four Short-tailed Shearwaters were recorded. Two were sighted between 5 and 10 January 1976 by shipboard observers; one of these was seen approximately 27 km northwest of San Nicolas Is. just east of the Santa Rosa-Cortés Ridge, and the other about 30 km west-southwest of Pt. Loma. Two others were encountered in February 1976, the first about 30 km southwest of San Clemente Is. and the second 15-20 km west of Santa Catalina Island.

Manx Shearwater (Puffinus puffinus)

This species was recorded three times (6 individuals) from September through December. The low numbers seen on our standard transect runs at least partially reflect the fact that areas sampled were generally more than 13-15 km offshore, farther out than the zone most often frequented by these birds.

Fork-tailed Storm-Petrel (Oceanodroma furcata)

We recorded Fork-tailed Storm-Petrels on four occasions this year. On 27 June 1975, one bird was seen flying well offshore about 41 km due west of San Nicolas Is. Three shipboard sightings were made between 16 and 21 November 1975: one directly over Osborn Bank near Santa Barbara Is., the second 22 km southeast of that island and the third close inshore, 15 km west of Newport Beach.

Leach's Storm-Petrel (Oceanodroma leucorhoa)

Leach's Storm-Petrels were common in the study area from late summer through fall in 1975, attaining peak numbers during July - August. They were generally found more than 30 km offshore and seemed to concentrate over shallower bank areas. They were the only petrels to be consistently found west of longitude 120°30' W.

Ainley et al. (1975) surmised that this species is to be found primarily in warm, subtropical waters west of the major flows of the California Current. In 1975, Leach's Storm-Petrels were consistently more numerous in the relatively warm waters southeast of San Clemente Is. than elsewhere, but were also the most numerous storm-petrels in the San Miguel Is. and Cortés Bank areas, where upwelling and the California Current combine to keep water temperatures cool. The species was quite common within 40 km of shore near San Diego. Thus, our data provide support for the thoughts of Ainley et al. (1975) about the temperature preferences of the species, but fail to support their conclusions about proximity to the mainland coast.

Ashy Storm-Petrel (Oceanodroma homochroa)

Ashy Storm-Petrels occurred erratically, being uncommon to common in certain areas of the Southern California Bight this year (Fig. III-216). Numbers varied from only one or two birds in April, May, August, November and January to a peak of 120 birds in July over Santa Cruz Basin. Two other peaks, one in September and one in December were noted. The species tended to occur more regularly in the northern half of the study area (with the notable exception of a December sighting over Tanner Bank). As proposed by Ainley et al. (1975) the

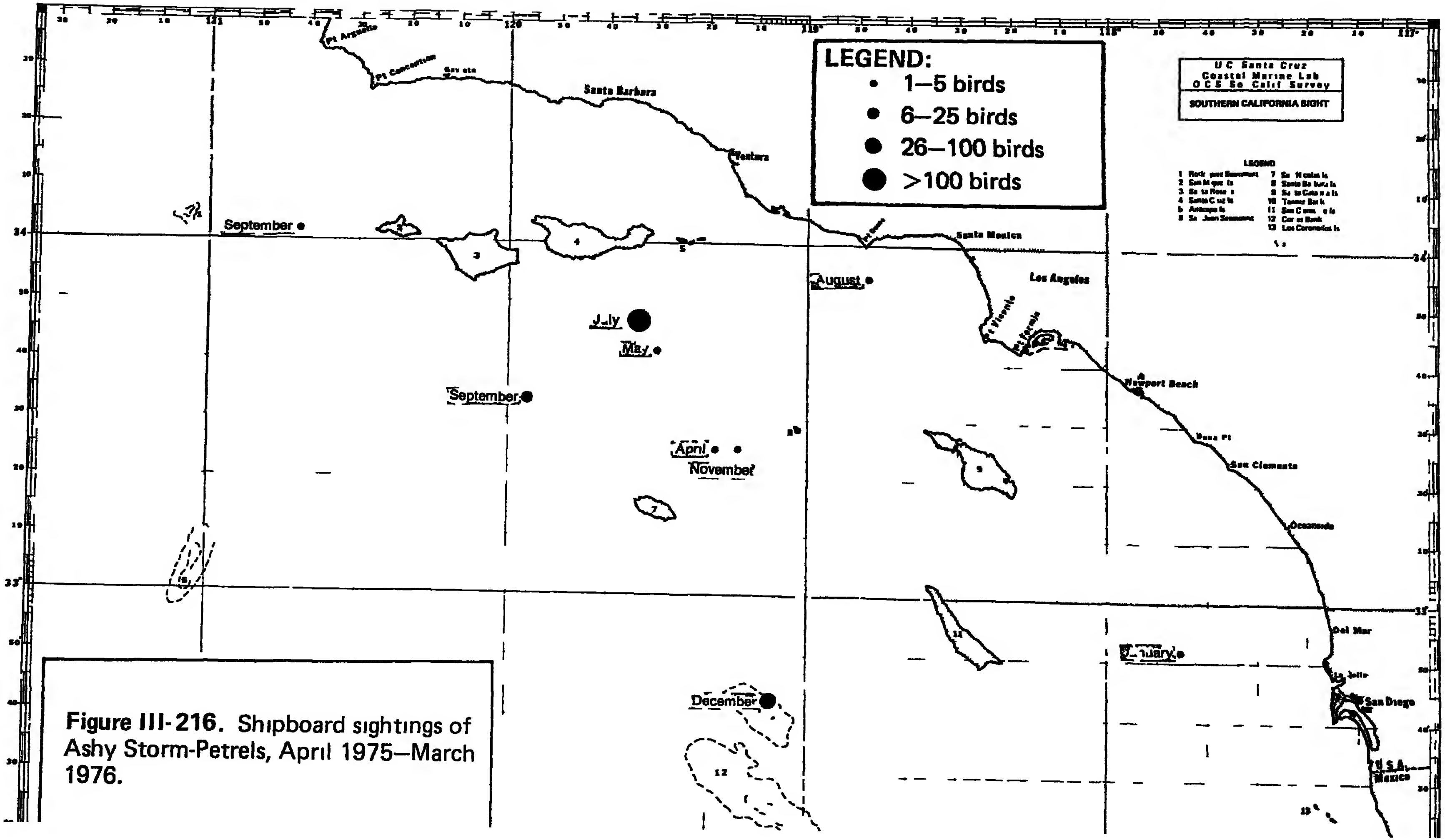

Figure III-216. Shipboard sightings of Ashy Storm-Petrels, April 1975—March 1976.

species was most abundant in cool waters near its nesting grounds.

Black Storm-Petrel (<u>Oceanodroma melania</u>)

Black Storm-Petrels were irregularly common to abundant in the Southern California Bight during our survey year. They were consistently present in moderate numbers from San Clemente Is. southeast to the mainland and also near shore from Pt. Vicente west to Santa Cruz Channel. Peak numbers were noted in September and December.

Least Storm-Petrel (<u>Halocyptena microsoma</u>)

Our single observation of this species was of one bird in northeasterly flight 54 km due west of the Mexican border on 29 August 1975.

Red-billed Tropicbird (<u>Phaethon aethereus</u>)

We saw eight Red-billed Tropicbirds between 19 June and 12 September. Most were seen far offshore in the vicinity of the Santa Rosa-Cortés Ridge and Tanner and Cortés Banks. McCaskie (pers. comm.) reported four more seen on a Western Field Ornithologists Pelagic Trip near the south end of San Clemente Is. in September.

Brown Pelican (<u>Pelecanus occidentalis</u>)

Throughout spring and early summer we found low numbers of Brown Pelicans at sea and on mainland beaches. Several hundred individuals were counted among the northern islands, where they nested. Total numbers swelled greatly from August through October with the expected influx of birds from Mexican colonies. In the period of peak abundance (September through December) we found pelicans at sea out to the eastern side of the Santa Rosa-Cortés Ridge. In early autumn the area of primary concentration included the northern and central islands,

but the main mass of birds shifted southeastward in late autumn. Throughout the winter months we found them nearshore among the islands, becoming more concentrated at San Clemente Is. with time. Numbers throughout the Bight dwindled from December onward, reaching low ebb in March.

This pattern confirmed the expectation that almost all Brown Pelicans in southern California in spring and early summer were locally nesting birds, with virtually no residual population away from the nesting colonies. Mexican birds flooded into and through the area in August, peaked in numbers in autumn, and apparently departed southward in December through February. Foraging and feeding were observed throughout the Bight in all areas and times that pelicans were recorded.

Interestingly, the proportion of immature to mature birds was high (and relatively constant) on mainland shores, considerably lower on Santa Cruz Is. (where adults predominated in the nesting season and immature birds appeared in strength only during the period of dispersal of the Mexican populations), and was consistently quite low at sea. Immature birds varied from 0 to 15% of all sightings more than 15 km from shore throughout the year. The possibilities that a) immature birds have a more inshore distribution than adults throughout the year, and b) the post-nesting influx of Mexican birds is heavily biased to the lower age classes and passes primarily along the coast are under investigation. Anderson and Anderson (1976) present age ratio data that in part corroborate each of these proposals and also demonstrate seasonal variability of age ratios at various coastal sites.

Double-crested Cormorant (Phalcrocorax auritus)

The Double-crested Cormorant was found almost exclusively on the immediate coastlines of the Channel Islands (particularly near the known nesting colonies at Prince Is., Santa Barbara Is. and Anacapa Is.), and on mainland beaches. Total numbers were highest in September and in the winter months. Although the species nests at Santa Barbara Is., we never recorded birds foraging nearby at sea. Records of several birds east of San Clemente Is. were noteworthy in that we know of no nearby nesting station.

Brandt's Cormorant (Phalacrocorax penicillatus)

In the months of April through June, Brandt's Cormorants were found in large numbers near and on the major nesting colonies among the four northern islands, particularly at San Miguel Is. and Santa Rosa Is. They were less numerous on other islands, scarce at sea (present only in the vicinity of colonies) and virtually absent from the mainland beaches included in our censuses.

In July through October, we found the species somewhat more common at sea, occasionally 40-50 km from shore. There were several distant sightings west of San Diego and west of San Clemente Is. Nevertheless, Brandt's Cormorants remained more numerous close to the northern and central islands. The year's high count of this species onshore occurred in October when 11,277 birds were found on seven islands (Anacapa excluded).

During the winter months, counts at the northern islands dropped somewhat, while at San Nicolas, Santa Barbara and San Clemente islands they increased. We found the species in low densities in the waters

of Santa Barbara Channel, Santa Cruz Basin, and the Gulf of Santa Catalina. Evidently, these birds were not restricted to the immediate vicinity of island shores in winter, while still forming large roosts on several of the islands each night. (Bartholomew [1942] described a tendency of Brandt's Cormorants to leave their roosts in San Francisco Bay each morning for foraging and to return in late afternoon to the same spots.) There was a slight indication of increasing numbers on the most northwestern islands in March, suggesting the onset of the 1976 nesting season.

Pelagic Cormorant (Phalacrocorax pelagicus)

The difficulties involved in censusing Pelagic Cormorants on cliffs from the air, and lack of complete inshore ship surveys until the winter months, render our data on this species somewhat inadequate. Birds were present on each of the four northern islands throughout the spring (and probably summer and fall as well), but records from July through October were scarce. In December through March, we found 259 birds on the northern islands; largest numbers were found on the east coast of San Miguel Is. and the south coasts of Santa Rosa and Santa Cruz islands. We recorded a few Pelagic Cormorants at sea, again primarily near the northern islands. Even fewer were noted on the mainland.

This species then, was almost totally restricted to the immediate coastlines of the northern islands and Santa Barbara Is., rarely occurring offshore (corroborating Scott 1973), and was nearly absent from the mainland. Pelagic Cormorants were much less abundant throughout the study area than Brandt's Cormorant.

Brant (<u>Branta bernicla</u>)

The large numbers of Brant observed in April were undoubtedly northbound migrants. There were no records during the summer. Single records in September and November were probably returning southbound birds. Brant went unrecorded in mid-winter (December - January). Those birds observed in February and March were either winter visitors, or early migrants through the Southern California Bight.

The data for the first year are too spotty to allow a reliable determination of the winter status and migration dates for this species.

White-winged Scoter (<u>Melanitta deglandi</u>)

White-winged Scoters were recorded only once in the spring. Some of the unidentified scoters observed in this period may have been of this species. The earliest winter sightings were in December, when small numbers of these scoters were well distributed around the Bight. Peak concentrations occurred inshore around the northern islands in January and February, with reduced numbers remaining there through March.

Surf Scoter (<u>Melanitta perspicillata</u>)

Surf Scoters were present in the inshore waters of the mainland coast and the northern islands in gradually declining numbers from April through June. They were unrecorded in July, but the few unidentified scoter records from the month were probably of this species. Scoters were absent from the Southern California Bight in August through October, with the exception of one large flock (462 birds) at P.M.T.C., Pt. Mugu, on 4 August. These were probably summering birds. Surf Scoters appeared along the mainland coast in November.

Counts there continued to increase up to a mid-January peak. Subsequently numbers became gradually reduced coastally through March. Surf Scoters were widely recorded offshore (more than 5 km), specifically around certain islands in November, but were nearly absent everywhere off the coast in early December. By mid-January large numbers of scoters were widely distributed throughout the inshore areas of the northern islands. While scoter numbers continued to increase there through February and March, distribution became less and less widespread. By March most birds were concentrated near Santa Rosa Island.

Red-breasted Merganser (Mergus serrator)

Red-breasted Mergansers went unrecorded from mid-April through May, suggesting that spring migration may occur earlier. The single bird observed in June may have been a summering non-breeder, but no birds were recorded through the remainder of the summer. In fall (September - November), increased numbers appeared at P.M.T.C., Pt. Mugu, on the mainland coast. In December came the first marked dispersal, as birds were present along much of the mainland coast and at Santa Cruz Is. By February, the majority of mergansers were concentrated inshore around the northern islands, and at P.M.T.C. March counts were somewhat reduced, with concentrations occurring on the south coast of Santa Rosa Is., and at P.M.T.C.

Red Phalarope (Phalaropus fulicarius)

We saw very few Red Phalaropes in April and May, indicating that migration either occurred earlier than the start of our survey program or took place in waters west of the Santa Rosa-Cortés Ridge (where

we did not sample). None were seen in summer until August and September, at which time they were scattered in small flocks throughout the inshore and offshore waters of the Southern California Bight.

The species was absent in November and December but censuses far offshore in January revealed moderate densities of Red Phalaropes over and beyond the Santa Rosa-Cortés Ridge. Unidentified phalaropes seen in the same areas were probably also of this species. This evidence suggests that a substantial number of birds wintered off the southern California coast. We did not sample far offshore in March, but at that time Red Phalaropes were moving through the inshore waters of the study area.

These results corroborate and complement those presented by Pyle and DeLong (1968 ms) for waters from about 90 to several hundred km west of our study area. In their study, this species was very abundant in spring migration and pushed southward in August. Red Phalaropes were scarce in that year from September through October, became very abundant in November and December, dropped in January, and were very abundant in February and March. Evidently, in both 1967-68 and 1975-76 spring and fall migrations were far offshore and many birds wintered off the coast.

Northern Phalarope (Lobipes lobatus)

Northern Phalaropes were recorded at scattered locations among the northern Channel Islands and San Pedro Channel in April and May 1975; the spring migration was apparently over by mid-May. The species was absent until mid-July. By the first of August we recorded Northern Phalaropes at many inshore and offshore locations. This

evidence suggests Northern Phalaropes arrive several weeks earlier than Red Phalaropes.

The southward migration peaked in early September and declined by the first of October. Few if any birds remained through the winter.

Northern Phalaropes were most numerous in waters inshore of the Santa Rosa-Cortés Ridge.

South Polar Skua (Catharacta maccormicki)

We recorded 17 skuas between 30 June and 18 November 1975 with most records (12) from September. The majority of records were from the Santa Rosa-Cortés Ridge and Cortés Bank. Either skuas are not as rare in southern California waters as previously supposed or 1975-76 was an especially good year for them. The number of skua sightings has increased steadily in each of the last 3-4 years, but this may be due to increased numbers of observers at sea. The frequency of observations over offshore banks and ridges suggests that skuas concentrate in waters over prominent features of submarine topography.

Pomarine Jaeger (Stercorarius pomarinus)

Spring migration was in progress when our sampling began in late April 1975. Pomarine Jaegers were scattered in offshore waters and between the Channel Islands and southern California mainland; densities at sea were low. The species was rare in June and July, and southbound migrants began to move through the study area in August. The highest densities of this species were recorded in September through November. Overwintering birds remained through March, 1976, by which time numbers had decreased considerably. Pomarine Jaegers were seldom recorded close to the mainland, but were common far out to sea and over

offshore banks and ridges.

Parasitic Jaeger (Stercorarius parasiticus)

Parasitic Jaegers were found primarily along the mainland coast. This species was most common in fall migration and early winter, though our data on seasonality were meager. We recorded this species once in May, two to four times per month from August through January, and only once thereafter. Parasitic Jaegers were greatly outnumbered in the study area by Pomarine Jaegers in all months.

Long-tailed Jaeger (Stercorarius longicaudus)

One was recorded near the southwest edge of Tanner Bank, 70 km southwest of San Clemente Is. on 11 September 1975.

Glaucous-winged Gull (Larus glaucescens)

Glaucous-winged Gulls apparently arrived in the Southern California Bight in October in 1975 and were present in fairly large numbers through March 1976. The peak in abundance of this species occurred from January through March, and most of the birds we saw were first- and second-year immatures. Our records show concentrations of Glaucous-winged Gulls on the northwesternmost of the Channel Islands (San Miguel and Santa Rosa islands); a few reached San Nicolas, Santa Cruz and Santa Barbara islands. Thus our records suggest this species prefers the cool waters and islands having pinniped rookeries in the western part of the study area. On the central California coast, Glaucous-winged Gulls are known for their habits of scavenging placentae and other carrion from pinniped rookeries and hauling grounds (Briggs unpubl. data). On the mainland, most records came from Ventura Co. from November through February.

Very small numbers were recorded at sea, though one sighting about 160 km southwest of San Nicolas Is. seems to confirm the expectation that some individuals wander well offshore.

Western Gull (Larus occidentalis)

Throughout the spring and early summer, Western Gulls were found in greatest numbers near the major breeding colonies -- San Miguel, Anacapa, San Nicolas, and Santa Barbara Islands -- and for 10 to 30 km offshore of these areas. They were not nearly as common in those months on mainland beaches as in the winter. By August, birds began to appear at sea, and the major concentrations shifted to the southeast rather than the northwest quarter of the study area, as was the case earlier in the year.

Juvenile birds were found in large numbers at sea and on the mainland for the first time in September. The species became particularly abundant at sea a month later, perhaps indicating an influx of birds from other nesting regions. Western Gulls continued to be numerous in the southeastern portion of the study area through November but massed along the northern Santa Rosa-Cortés Ridge in December through February. In March these birds were most abundant on the mainland and among the northern islands, particularly near nesting areas. They never appeared at sea beyond the Patton Escarpment, though our censusing there was limited.

Herring Gull (Larus argentatus)

A few Herring Gulls trickled into the Southern California Bight in October and November, but the species was not encountered commonly until January. In that month, several hundred birds turned up on

the islands and mainland beaches and others were seen scattered through waters in the northwestern third of the study area. February beach counts of this species were lower than those in January, and birds were found both near the northern islands and in the Gulf of Santa Catalina. In March, we found still fewer birds on the mainland but fairly large groups on San Miguel, Santa Rosa, and San Nicolas islands. Birds were scattered in open ocean areas primarily more than 40 km offshore. Northward migration appeared to be by gradual diminution of numbers on beaches and at sea from the peaks found in January and February.

Thayer's Gull (*Larus thayeri*)

We saw no Thayer's Gulls at sea. Two immatures were sighted in November 1975 -- one at Christy Beach, Santa Cruz Is. on the 9th, the other at San Onofre S.B. on the 12th. One juvenile was seen at San Onofre on 24 February 1976 and one at Gull Is. on 20 March 1976.

According to Devillers et al. (1971), about 2-5% of the Herring-type gulls at garbage dumps in the San Diego area belong to this species. Our 1975-76 censuses do not adequately reflect the abundance of Thayer's Gulls in the Bight, as we did not count near disposal areas.

California Gull (*Larus californicus*)

From April through September California Gulls were found very rarely at sea and only once (April) on the Channel Islands. A few hundred birds, primarily juveniles, appeared to spend the summer at Dockweiler S.B. and Huntington S.B. but the species was not found with any regularity at other mainland sites. In October through December, we

recorded a large-scale influx of California Gulls, first into the offshore waters, and later onto island and mainland beaches. Numbers peaked both at sea and ashore in January; very large groups were found south of Santa Rosa Is., near Santa Catalina Is., and ashore on San Diego beaches. The distribution of birds at sea apparently conformed to the spawning grounds of squid.

The species became progressively more scarce and withdrew to a few areas of local concentration (the northern islands area) in the months of February and March. This decline clearly indicated the onset of the spring return toward northern, inland nesting grounds.

Ring-billed Gull (Larus delawarensis)

This was the gull species most strictly coastal in distribution. In the entire year only two Ring-billed Gulls were seen offshore of the mainland coastline and these were found just off Pt. Vicente. Numbers showed a decline in spring 1975, but up to about 175 birds apparently spent the summer on the nine mainland beaches we surveyed. Large concentrations of birds were found at several locations during the winter months, the coastal lagoons typically harboring many hundreds at a time. Birds drifted out of the area from January onward, and by March relatively few remained.

Mew Gull (Larus canus)

We first recorded Mew Gulls along mainland beaches in December 1975, and several hundred birds were encountered at sea, along beaches, and near the shores of the four northern Channel Islands in January. Many more birds were seen in the area from Santa Barbara Channel to San Pedro Channel than south of there. Numbers clearly peaked in

January - February and declined considerably in March, indicating the beginnings of the northward exodus of wintering birds in the latter month.

Our only observation of Mew Gulls feeding at sea was of 15 birds that joined in a large, mixed-species flock in eastern Santa Barbara Channel on 24 January 1976.

Bonaparte's Gull (Larus philadelphia)

Northward migration was underway in April 1975, when we began sampling. Beach and inshore counts were low, but one transect across Santa Cruz Basin revealed fairly large numbers of birds moving north over open water. A very few birds were recorded in May, signaling the passage of the last of the migratory individuals. None were found from June through September.

A few Bonaparte's Gulls turned up in October, but the main wave of migration occurred offshore in November. In that month Bonaparte's Gulls were widely-distributed offshore as far as San Nicolas and San Clemente Islands, outnumbering all other larids except the California Gull. In December and subsequent months, Bonaparte's Gulls withdrew from the open-ocean waters of the Southern California Bight and concentrated in the immediate vicinity of the mainland coast.

The major concentration areas for this species in the winter of 1976 were in Santa Monica Bay near Pt. Vicente, at Huntington S.B., and within 10 km of San Diego. Offshore of Pt. Vicente we repeatedly encountered many hundreds of birds in association with other gulls and purse seiners, where all were presumably taking spawning squid.

Heermann's Gull (*Larus heermanni*)

Heermann's Gulls were found infrequently in the offshore waters of the study area, rather often on the beaches of the Channel Islands, and quite commonly on mainland beaches. Some birds were present in all months, with peak numbers July through September. Most records were concentrated in the sector bounded by Pt. Vicente, Santa Catalina Is. and San Onofre S.B. The only major concentration seen more than a few km from land was a group of birds in Santa Barbara Channel in January 1976. Sightings at sea were too infrequent to detect a return migration (southbound) in winter and spring, but attrition of total numbers on islands an mainland beaches was evident after September. After mid-January very few birds were counted anywhere in the study area.

Black-legged Kittiwake (*Rissa tridactyla*)

The first real influx of this species in offshore waters occurred in December, with local concentrations northwest of San Miguel Is. and southeast of Anacapa Is. Kittiwakes were never very common on mainland or island beaches, but by January they were very abundant offshore. The northern Santa Rosa-Cortes Ridge harbored large numbers throughout the winter as did the Tanner-Cortés Banks area in January. Considerably fewer birds were seen in the waters inshore of Santa Catalina and San Clemente Is. throughout January - March. Surprisingly, aerial transects in January indicated relatively few birds were present offshore of the continental margin.

In contrast to the findings of Harrington (1975) and others for both coastal and open-ocean waters, adults were relatively abun-

dant throughout the Southern California Bight in 1975-76. Analysis of 260 sightings, selected at random from among approximately 750 total sightings of this species in January through March 1976, gave an adult : immature ratio of from 9:1 to 501:1, depending on location and date. In no area did we find immatures more numerous than adults.

Since young gulls often migrate farther south than adults, it is likely that in this year of high Black-legged Kittiwake abundance, the young birds wintered south of the study area.

Sabine's Gull (Xema sabini)

Our data on spring migration indicate that birds were moving north along the Santa Rosa-Cortés Ridge and through Santa Cruz Basin in April through late May. None were seen in the summer months. Southward migration was in progress in early September, but birds were widely scattered and in very low densities. No Sabine's Gulls were recorded in winter. Our mid-March sighting of a single bird east of Santa Catalina Is. appears to be the earliest spring record for the region.

Forster's Tern (Sterna forsteri)

Forster's Terns were frequently observed at selected southern California beaches in all but two months of the year (Table III-129). They were not recorded in either April 1975 or in January 1976. The months of greatest abundance were October and November 1975 and March 1976 when these terns were present on all but five beaches censused. Highest counts were taken at Dockweiler S.B. in October and November and at Border Field S.B. in March.

In addition, there was one at-sea sighting of a single bird

Table III-129 . Frequency of sightings of Forster's Tern (total individuals) at selected southern California beaches April 1975 through March 1976. Dash indicates beach not surveyed. Numbers in parentheses are lengths of beach surveyed in km.

	Santa Cruz, North	Santa Cruz, West	Santa Cruz, South	McGrath S.B.	P.M.T.C., Pt. Mugu	Pt. Mugu S.B.	Dockweiler S.B.	Huntington S.B.	San Onofre S.B.	South Carlsbad S.B.	Silver Strand S.B.	Border Field S.B.	Totals
	(4.3)	(4.2)	(5.7)	(3.0)	(3.1)	(3.3)	(5.6)	(3.3)	(5.0)	(9.3)	(5.7)	(2.6)	(56.8)
11-27 April, 1975	0	0	0	0	-	0	-	-	0	-	0	0	0
11-24 May	0	0	0	10	-	0	0	0	0	0	0	0	10
13-19 June	0	0	0	0	-	0	0	0	0	0	4	15	19
11-18 July	0	0	0	0	0	0	0	1	0	0	8	0	9
1-7 August	0	0	0	0	3	0	5	0	2	0	0	0	10
11-18 September	0	0	0	9	0	0	0	0	0	0	-	-	9
15-18 October	0	0	0	4	3	6	38	2	0	4	-	-	57
6-14 November	0	0	0	1	21	0	38	1	1	6	0	9	77
4-11 December	0	0	0	3	1	0	6	10	0	3	1	7	31
11-18 January, 1976	0	0	0	0	0	0	0	0	0	0	0	0	0
16-24 February	0	0	0	0	12	0	2	0	0	0	1	0	15
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

on 7 May 1975, 15 km west of Newport Beach.

Common Tern (*Sterna hirundo*)

Common Terns were seen in May and from September through November. As expected, their numbers in fall migration were greater than in spring, but our sample sizes were small. With the exception of a few records in May and September, we only saw this species along mainland beaches. Of the three offshore records, one was of northward migrating birds just off Dana Pt., one was near Santa Cruz Is., and one was at Tanner Bank. None were seen in summer or winter.

Arctic Tern (*Sterna paradisaea*)

The difficulties of distinguishing this species from the Common Tern create some confusion about the dates and geographic limits of migration. Arctic Terns were positively identified east of Santa Catalina Is. in May. They were not seen again until August, when low densities were found along the northern Santa Rosa-Cortés Ridge, near San Clemente Is., and west of San Diego. This pattern of distribution held through September, after which we recorded no additional sightings.

Im comparison with Common Terns, these birds were seen much farther offshore, with concentrations only out at distances greater than 25 km from the mainland. None were found on the mainland coastline during our beach censuses and only one at the immediate shores of the islands.

Least Tern (*Sterna albifrons*)

Sightings of Least Terns during the 1975-76 survey year were scattered and sporadic on beaches and in harbors. Regular sightings

were made at nesting sites at Huntington S.B. and P.M.T.C., Pt. Mugu. At the latter location, birds were recorded until September, and a single Least Tern carcass was recovered there in November. Other sightings were made at San Diego and Long Beach Harbors, and at McGrath S.B. in August, indicating possible nearby breeding activities. Only two birds were recorded at the Border Field colony.

Royal Tern (Sterna maximus).

Royal Terns first appeared in the study area in August 1975, became common in September, and declined in numbers after January 1976. They were apparently more numerous among the Channel Islands than our mainland beach census areas. Very few were encountered at sea, and then only close to one of the islands. There were two obvious centers of abundance of Royal Terns; one included the four northern Channel Islands, Santa Barbara Channel and east to P.M.T.C., Pt. Mugu; the other was on San Diego Co. beaches. San Nicolas Is. harbored up to 25 birds during three complete censuses in October through January.

Elegant Tern (Sterna elegans).

Elegant Terns were observed along mainland beaches from 18 June to 14 November. The first birds appeared on San Diego beaches in June, with peak numbers appearing in July and August on the three southernmost beaches. By September Elegant Terns had reached the northernmost beaches. Very few were seen after October, when most had migrated south.

We saw no birds around the Channel Islands and had only one sighting away from the immediate mainland coast: two birds seen 15 km southeast of Pt. Dume on 25 August.

Caspian Tern (*Hydroprogne caspia*)

This species was frequently seen at P.M.T.C. and Pt. Mugu beaches and irregularly at other mainland beaches. Total numbers were small from April through August, hit a peak of 121 birds in September, then dropped off to zero by November. About two dozen birds appeared at P.M.T.C. in December and January and remained through the winter, as did a small number at San Diego.

No Caspian Terns were recorded offshore or around the Channel Islands.

Common Murre (*Uria aalge*)

Common Murres were absent from the Bight from late spring until late fall, with none recorded between April and October. Moderate numbers were seen in the northwest sector of the Bight from November through March, concentrating particularly in the eastern half of Santa Barbara Channel where densities of up to 65/km^2 were encountered. Moderate numbers were regularly seen in the northern island passages, and in Santa Monica Bay. The southernmost sighting of this species was of a single bird near Fortymile Bank (32°35' N/117°45' W) in January. During that month, moderate numbers were also seen out to Rodriguez Seamount. In March, numbers had diminished in Santa Barbara Channel, but large concentrations were observed in the northern passages, possibly massing for northward migration to the breeding colonies.

Pigeon Guillemot (*Cepphus columba*)

Pigeon Guillemots were commonly found during spring and summer months in the immediate vicinity of breeding sites at San Miguel,

Santa Rosa, Santa Cruz, Anacapa and Santa Barbara Islands. They were rarely encountered more than four km from shore, and then only in the island passages. Inshore surveys during the 1975-76 survey year were often spotty or incomplete, making a complete picture of Pigeon Guillemot inshore distribution in southern California impossible to attain. Most locations of inshore guillemot aggregations are known, however, with data on specific numbers and dates of occupation remaining unclear. The winter distribution of these birds in southern California is virtually unknown. We encountered no Pigeon Guillemots from mid-August until mid-February when three birds were seen near San Miguel Is., as they apparently began returning to breeding sites there. Two of the February birds were in winter plumage, the only such guillemots recorded during our 1975-76 surveys. By mid-March, guillemots were again commonly seen in the vicinity of all their usual breeding locations.

Xantus' Murrelet (Endomychura hypoleuca)

Data on the distribution of Xantus' Murrelets around their primary nesting island (Santa Barbara Is.) are present in pp. III-700 to 714. Xantus' Murrelets were found in moderate to high densities in the vicinity of their breeding colonies during the spring months (April - May 1975). By June, these birds had apparently dispersed since few birds were seen near the breeding colonies, and most sightings were from the offshore regions. By July, murrelet sightings were concentrated along the northern Santa Rosa-Cortés Ridge, although other birds were seen near Santa Barbara Is., Pt. Vicente and San Clemente Is. From August through December few murrelets were found in the Bight, with minor concentrations observed near Fortymile Bank and Tanner-Cortés Banks.

By January murrelets were again seen in larger numbers in the area northwest of Santa Barbara Is., especially along the northern Santa Rosa-Cortés Ridge. Murrelets were seen as far offshore as San Juan Seamount during aerial surveys conducted during January. By February, Xantus' Murrelets were found concentrated south of Santa Barbara Is. and near Prince Is., apparently having returned to nesting areas. March surveys revealed the typical spring distribution pattern for this species with large numbers found in the immediate vicinity of nesting sites, with few found elsewhere.

Craveri's Murrelet (Endomychura craveri)

This species was recorded only once during the first year of study, when a pair were observed at Cortés Bank on 11 September 1975. At least a few of the sightings of "murrelet sp." in August and September may have been of this species.

Ancient Murrelet (Synthliboramphus antiquus)

Ancient Murrelets were recorded only twice during the first year of study. A single individual was observed from the plane on the 6th of January 1976, 10-20 km southwest of Pt. Conception. Another oil-soaked, individual was found washed up at McGrath S.B. on the 14th of January.

Cassin's Auklet (Ptychoramphus aleuticus)

Cassin's Auklets were seen in all areas of the Southern California Bight during our surveys. Generally, winter concentrations were found near San Miguel Is., Anacapa Passage, along the Santa Rosa-Cortés Ridge, and near San Diego. Summer concentrations were located near the large colonies at San Miguel Is. Radial ship tracks from San

of Hoffman et al. (1975) who noted a trend of increasing occurrence of this species in southern latitudes during the last twenty years, which they relate to long-term oceanographic anomalies. These authors cite evidence that the birds found in southern California are quite possibly wind-blown non-breeding adults wintering in the central North Pacific.

Tufted Puffin (*Lunda cirrhata*)

Tufted Puffins were found to be rare to uncommon in the Southern California Bight in the 1975-76 study year. A total of 30 birds assignable to this species were seen during our surveys this year. Most sightings were made during January in the vicinity of Santa Cruz Basin and offshore of San Miguel Is. Other sightings were sporadic, but all occurred during the winter or spring in the northwestern quarter of the study area. No sightings of this species were made between July and December.

D. Discussion

The marine avifauna of the Southern California Bight is both large and complex; the 64 species for which baseline data were collected in 1975-76 comprise six major faunal elements, each of which is characterized by unique patterns of movement and seasonal abundance. Some of these faunal groups have been described or categorized several times in the past (e.g. Howell 1917, Scott 1974, Small 1974), but none of these authors have had the benefit of the broad and systematically collected data presented here. Accordingly, we present a synopsis of the major divisions of the southern California marine avifauna, emphasizing species that we found to be conspicuous in 1975-76. This classification will then be used as a basis for discussion of the significant eco-geographic features of our data.

1. Faunal elements

a. Nesting species

We recorded a total of nine seabird species nesting on the California Channel Islands in 1975-76: Ashy Storm-Petrel, Brown Pelican, Double-crested, Brandt's and Pelagic Cormorants, Western Gull, Pigeon Guillemot, Xantus' Murrelet and Cassin's Auklet. Three other species, Least, Caspian and Elegant Terns, nest on mainland beaches, though the latter has only one U.S. colony, in south San Diego Bay. Three other species have nested in the area in the past: Common Murre and Tufted Puffin on the Channel Islands, and Royal Tern, once in San Diego. These latter three species are not discussed further here.

Of the regularly nesting species, seven (pelicans, three cormorants, gulls, murrelet and auklet) are year-round residents in

the Southern California Bight. The Ashy Storm-Petrel may also be resident all year. Despite the term "resident", there is considerable seasonal movement of the populations of most of these species. The Brown Pelican reaches the northern limits of its present breeding range on Anacapa Is. and the number of nesting pelicans present in the Bight during the breeding season (March-June) is actually quite small compared to the large influx of pelicans from Mexican breeding colonies after the breeding season (see Anderson and Anderson 1976). Western Gulls, particularly immatures, exhibit some tendency to move to mainland beaches and garbage dumps after the breeding season and their numbers are supplemented by small numbers of Western Gulls (L. o. occidentalis) from north of the area in winter.

It is not clear at present what happens to the bulk of the Channel Islands' Xantus' Murrelet populations after the breeding season. They disperse away from their breeding islands in June and July and become considerably less abundant in the area until January when the first murrelets return to their breeding grounds. Some murrelets disperse northward in late summer as evidenced by occasional murrelet observations in Monterey Bay and the San Francisco area between August and March (McCaskie and deBenedictus 1966).

The Cassin's Auklet population is relatively stationary, although there is a distinct shift away from the waters around their breeding colonies in fall and winter and a slight southward shift as well. Whether auklets from farther north reach southern California in winter is not known. Banding data from the Farallons indicate that the large population there winters primarily in Monterey Bay

The three cormorant species are probably the most sedentary of the breeding seabirds in the Bight. The year-round population on the islands as a whole appears to remain rather constant, though there is some inter-island shifting of numbers, perhaps in response to continually shifting food supplies.

The Ashy Storm-Petrel is difficult to distinguish from other species of storm-petrels, thus its at-sea distribution and seasonality is not well known. Our data from 1975-76 and unpublished data of Jones, McCaskie and others from former years, suggest that they are present in the area in small numbers at least from May to January, and perhaps all year.

The other four species - Pigeon Guillemot and the three tern species - are clearly summer residents. Pigeon Guillemots are absent from southern California waters from September until February and it is not presently known where the Channel Islands' populations spend the winter. They do not go south, nor is there any indication of a northward migration. They might move out to sea, as suggested by Grinnell and Miller (1944), where few observation vessels venture and thus remain undetected at this season.

Least Terns begin to migrate south to South America in September and return again in April. Elegant Terns move northward into California from Mexico in late summer, often in large numbers, then depart for South America in October and November. The 100 or so pairs that nest in San Diego return from South America to breed in March (McCaskie pers. comm.). Though a few Caspian Terns regularly winter as far north as San Diego and occasionally farther north, the bulk of their population migrates to South America in October and

November, returning again in late March.

Although we are not yet able to provide estimates of total numbers of nesting seabirds in the Southern California Bight, it is clear that Brandt's Cormorant, Western Gull and Cassin's Auklet are the most numerous. Based on 1975 breeding census data, at least 3700 Brandt's Cormorants (1850 pairs) breed in the area (Table III-115) and another 7500 or so non-breeding individuals are present at any given time. The number of Western Gulls breeding in the Bight appears to be at least 6000 and perhaps as much as 10,000 with inclusion of the smaller islands and islets, plus an unknown number of scattered pairs on the larger islands (Table III-115). There are approximately 20,000 Cassin's Auklets breeding on Prince Is. alone and an unknown but undoubtedly smaller number on the other islands plus an unknown number of non-breeding individuals.

Other species are present in smaller numbers, at least during the breeding season. The number of Xantus' Murrelets breeding in southern California is not at all clear, though the approximately 2000 (1000 pairs) that nest on Santa Barbara Is. must represent the vast majority of the breeding population in the Bight. The total number of Pigeon Guillemots in the area is somewhere around 1000 on San Miguel and Santa Barbara islands, plus an unknown number (perhaps another 1000) present at Santa Rosa and Santa Cruz islands. In 1975, only 600 Brown Pelicans nested or attempted to nest in the area, but the total number present was many times higher by September when breeding bird numbers were augmented with birds from Mexican breeding colonies.

Numbers of Ashy Storm-Petrels, Double-crested and Pelagic

Cormorants in the Bight were considerably less and probably totaled no more than 2000 individuals combined in 1975 (excluding the immature Double-crested Cormorants found in coastal lagoons on the mainland).

b. Year-round visitors

This group includes those species that do not breed in southern California, but which can be expected at any time of year. Those species found in winter which are represented by a few over-summering individuals (e.g., loons, grebes, scoters) are not included here.

Two species of gulls and one tern which breed north of our area may be considered year-round visitors in southern California. The two gulls (California and Ring-billed) and one tern (Forster's), however, are much more abundant in our area from October to April. Two species, Black Storm-Petrel and Royal Tern, breed just to the south of us, the former on Islas Los Coronados in extreme northern Baja California and the latter on mainland beaches of central and southern Baja. Both these species are present year-round south of latitude 33°N, but the storm-petrel is apparently irregular or scarce in winter north of there and the tern is absent in spring north of San Diego. The Black-footed Albatross breeds in the central Pacific and a few individuals can be expected far offshore at any season.

c. Summer visitors

Six species can be listed in this category, three of which nest to the south in Baja California, two more of which nest in the southern hemisphere and spend their "winter" in our area, and a sixth species which nests both north and south of, but not in, the Bight. The Least Storm-Petrel, Red-billed Tropicbird and Craveri's Murrelet all nest in Baja California and quite regularly wander north

into southern California waters in summer and early fall. Leach's Storm-Petrel nests in Baja as well, but also nests from northern California to Alaska. It is present in southern California from April until October and is often found farther offshore than the other species of storm-petrels.

Two species of shearwater (Pink-footed and Sooty) which nest in the Southern Hemisphere and spend the austral winter in the Northern Hemisphere are found in southern California from April through December, with a few non-breeders remaining through the winter. At times Sooty Shearwaters are the most abundant bird in the Bight, with numbers reaching into the millions.

d. Winter visitors

This category includes nearly half of all the regularly occurring seabirds in southern California and generally represents the greatest biomass from October through April. A winter visitor is defined as any species which is present during the winter months; however, the vast majority of its population departs during the species breeding season. The category includes species such as Heermann's Gull which is present from June through March and Northern Fulmar which, when present at all, is found from November until June. Other species included in this group are: Common Loon (late October-May); Arctic Loon (late October-early June); Red-throated Loon (mid-October-late April); Horned Grebe (November-April); Eared Grebe (September-early May); Western Grebe (late September-early June); Short-tailed Shearwater (November-February [rare and irregular in occurrence]); Manx Shearwater (September-February); Fork-tailed Storm-Petrel (a rare and irregular visitor exhibiting no apparent seasonality); White-winged

Scoter (late September-late April); Surf Scoter (early October-early June); Red-breasted Merganser (late September-early May); Red Phalarope (early August-late May); Pomarine Jaeger (August-May); Glaucous-winged Gull (late October-mid-May); Herring Gull (November-April); Thayer's Gull (November-April); Mew Gull (November-April); Bonaparte's Gull (late October-late May); Black-legged Kittiwake (November-May [highly irregular in occurrence from year to year; after winters of big influx, many birds may remain through the summer]); Common Murre (November-April); Rhinoceros Auklet (December-April).

e. Transients

Birds in this group are those that pass through southern California waters while migrating between their wintering and breeding grounds. The New Zealand Shearwater is generally a rare fall transient (September-November), but a few records of strays exist for other seasons. Though Brant are winter visitors in southern California, they are strictly transients offshore, wintering in lagoons and estuaries away from the exposed beaches. Migrating groups can be seen traveling south in October and November and returning to their breeding grounds in the Arctic in March and April. Parasitic Jaegers are regular spring and fall transients, primarily to waters near mainland beaches. Though this species can be seen at almost any time of year, it is relatively scarce in mid-winter and in June and July. Long-tailed Jaegers migrate far offshore in fall and can occasionally be seen in the Bight between late August and early November. South Polar Skuas, the only species in this group that breeds in the Southern Hemisphere, can be seen between June and October as it passes southward along our coast during what is

thought to be a pan-Pacific clockwise migration (see Devillers ms cited in Jehl 1973). Sabine's Gulls are present in spring from mid-April until mid-June while on their way to Alaskan breeding grounds and again between mid-August and mid-October on their way south to South America where they spend the winter. A few birds can be seen through the summer, but none are present in winter. Common Terns are present (generally near shore) from April to June and August to November and Arctic Terns are present offshore from mid-April to late May in small numbers and from mid-July to early October in larger numbers. Horned Puffins are present in modest numbers between early May and early June. One theory (Hoffman et al. 1975) suggests they winter in the mid-Pacific Ocean at latitudes as far south as southern California, a few drifting eastward with the currents, then migrating northward in spring along the California coast to Alaskan breeding grounds. Almost no seabird work has been conducted far at sea in mid-winter, thus it is not known what species are actually present there then.

f. Strays

Birds in this category occur in such small numbers that they are not considered part of southern California's expected avifauna. We found four such species in 1975-76. Three were strays from farther north and one was a stray from the central Pacific. The Red-necked Grebe and Ancient Murrelet normally do not occur south of central California, though we saw one of the former and two of the latter, all north of 34°N latitude. One of the murrelets was oil-soaked and probably drifted south after becoming incapacitated. One Laysan Albatross was encountered in January far offshore at Cortés Bank.

This species is only rarely seen within 180 km of the southern California coast.

A probable sighting of a Cape Petrel on 30 August 1975 is in a category all its own. Although there are a dozen or more reports of this species from the Northern Hemisphere (Atlantic and Pacific Oceans), only one or two of these have been properly documented (Bourne 1967).

2. Nesting colonies

In light of present records (and the summary of historical data, Appendix III-A3), it is clear that the populations of several species of seabirds that have nested in the California Channel Islands have declined. Of the eleven species that were breeding in the Channel Islands 75 years ago, two no longer nest there (Tufted Puffin and Common Murre) and five species (Brown Pelican, Double-crested Cormorant, Brandt's Cormorant, Pelagic Cormorant and Cassin's Auklet) have diminished in range, population size or both. The numbers of Western Gulls, Pigeon Guillemots and Xantus' Murrelets have apparently remained similar to what they were previously, although there may have been some distributional changes. The Ashy Storm-Petrel may have decreased in numbers, but this is a nocturnal, burrow-nesting species which is often difficult to detect. Its present-day population levels and extent of range on the Channel Islands remain poorly known.

A number of different factors has contributed to the decline of the various seabird populations, but virtually none of the causes of decline are adequately documented, with the exception of the

correlation between chlorinated hydrocarbon residue levels, eggshell thinning and reproductive failure. The losses of species at the fringe of their range (Tufted Puffins and Common Murre) and the loss of small populations of species from accessible islands (cormorants on Santa Catalina Is.) were undoubtedly hastened by the efforts of bird and egg collectors who particularly sought specimens of rare species. However, collecting does not seem adequate to explain the complete disappearance of colonies which, upon their last visitation, were "large", and it does not explain the decrease of the Brown Pelican, the three cormorants or the Cassin's Auklet. Other factors may have been involved, and three of these which need to be discussed include chlorinated hydrocarbons, disturbance and predation related to man, and environmental changes which have affected food supply.

Chlorinated hydrocarbons have been identified by Anderson and Anderson (1976) and others as a major factor in reproductive failure of the Brown Pelican and the associated decrease in the numbers of nesting pairs of this species in southern Californa. However, in the last few years it appears that the reproductive success of pelicans has improved and that we can hope for a gradual increase in their populations (Anderson et al. in press, Anderson and Anderson 1976).

Anderson et al. (1969) and Gress et al. (1973) have documented the decline of Double-crested Cormorants in the Channel Islands. They have linked this decline with decreases in eggshell thickness which in turn have been correlated with chlorinated hydrocarbon levels in adult tissues. R. Lust (in lit.) documented eggshell thinning in Brandt's Cormorants on San Nicolas Is. in 1973 which led to

reproductive failure. While detailed information on eggshell thinning and reproductive failure in Brandt's Cormorants and Pelagic Cormorants is not available at present, it is possible that pollution by chlorinated hydrocarbons has contributed to the decline of their populations.

Disturbance is another factor to which pelicans and cormorants are very sensitive, and it is likely that disturbance has contributed to the decline of these species. Both pelicans and cormorants are easily frightened from their nests, and gulls are quick to take the exposed eggs. Because predation related to disturbance can result in complete reproductive failure of a cormorant or pelican colony, it is critical to minimize disturbance of these birds while they have eggs or small young. It is for this purpose that West Anacapa Is. and Scorpion Rk. have been closed to all visitation during the pelican nesting season.

Predators such as cats and rats, when introduced to islands, may exterminate burrow-nesting forms. It is likely that cats caused the elimination of Cassin's Auklets from Santa Barbara Is. and rats have probably contributed significantly to the decline of Xantus' Murrelets on Anacapa Is. However, it is unclear why cats did not destroy the Xantus' Murrelet population on Santa Barbara Is.

The possibility that the long term fluctuations in food resources may have resulted in the decrease of certain seabird populations has been put forward by Ainley and Lewis (1974) to account for differences in the rate of increase of various species of seabirds on the Farallon Islands. They believe that the demise of the Pacific sardine (Sardinops caerulea) may have resulted in the decrease of

both the Tufted Puffin and the Double-crested Cormorant. It is possible that the Double-crested Cormorants in the Channel Islands have been affected by the loss of sardines, but in the Southern California Bight the decrease in cormorant populations seems to be a more recent phenomenon. The Tufted Puffins apparently disappeared from the Channel Islands long before overfishing destroyed the sardine stocks, and loss of sardines does not appear to be a good explanation for their decline.

Ainley and Lewis (1974) also believe that periodic fluctuations in the cold, nutrient-rich California Current and unusually long incursions of the warm, nutrient-depleted countercurrent may explain changes in local oceanic productivity which would affect seabird numbers and breeding success in central California. It seems unlikely that short-term fluctuations of the currents could account for long-term declines in seabird populations of the Channel Islands, although the fluctuations might be sufficient to push a small, marginal population to local extinction.

Short-term fluctuations in food resources may, however, be an important factor in the short-term population fluctuations and colony shifts observed in Brown Pelicans. We, along with others, have observed that an island supporting a large colony one year may not be used the following year. Also, pelicans beginning their breeding activities at a given site in February one year may not begin breeding there until May the next year. The same seasonal differences have also been observed at different sites in the same year. Such temporal and spatial shifting of breeding activity does not, of course, lessen the significance of the recent extended population decrease.

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Oil pollution has not thus far been identified as a cause of the decline of a population of seabirds nesting in the Channel Islands. However, on the Farallon Islands, Ainley and Lewis (1974) have linked sharp declines in Tufted Puffin and Pigeon Guillemot numbers to oil pollution. Because Pigeon Guillemots remain inshore near their breeding colonies from March until July, an oil spill at sea which subsequently came ashore near a guillemot colony could easily destroy the entire colony.

The factors discussed above may singly or together account for the decreases in populations of cormorants, pelicans, auklets and some murrelet populations. At present, insufficient knowledge of Ashy Storm-Petrel distribution and numbers in southern California precludes any speculation on their present-day status relative to past numbers.

In summary, while the present day populations of seabirds nesting on the Channel Islands are, in many cases, only a fraction the size of former populations, several islands support important marine bird populations. Anacapa and Scorpion Rk. are crucial because they support the only nesting colonies of the endangered Brown Pelican in California. San Miguel Is. and its surrounding islands support large populations of cormorants, gulls and alcids which will be exceedingly vulnerable to either spilled oil or such secondary effects of oil resource development as disturbance by aircraft over-flights, recreational visitation or infestation by rats or cats should shore facilities be developed. Xantus' Murrelets, which occur in large numbers on and around Santa Barbara Is. would be exceedingly

vulnerable to oil spilled on the water's surface in the vicinity of this island.

In contrast, other islands support relatively few nesting seabirds. San Clemente and Santa Catalina Islands have virtually no nesting seabirds. On the main island of Santa Cruz and on Santa Rosa Is. nesting seabirds are almost exclusively restricted to the northern sides, where Pigeon Guillemots and Brandt's Cormorants nest in modest numbers. An exception is the small dense colony of four species on Gull Is. off the southwest corner of Santa Cruz Is. Finally, on San Nicolas Is., nesting seabirds are restricted to modest numbers of Brandt's Cormorants and Western Gulls at the northwest end.

Maintenance and even recovery (as seen in the pelicans) of these populations of seabirds is possible if they are not subjected to disturbance or pollution. However, if levels of disturbance or pollution increase, it is likely that many of the seabirds presently nesting in the Channel Islands will be exterminated.

3. Distribution, numbers and seasonal dynamics

We collected observational data concerning 64 species of marine birds in our first year of study. Our understanding of distribution and seasonal dynamics varied with the number of sightings of each species; of some we saw but one individual all year while of others we encountered many thousands or even tens of thousands of individuals during a single cruise or flight. In order to give an overview of seabird activity throughout the first year of study, we present here quarterly accounts of the major faunal groups, emphasizing those taxa that contributed significantly to the density of the avifauna

as a whole.

a. April - June 1975

These months included the migratory periods of most purely transient and wintering species, the arrival of several species that summered but did not nest in the area, and much of the courtship, nest-building, egg-laying and incubation phases of the reproductive seasons of the nesting species. Surface water temperature varied from 10°C near San Miguel Is. to 15°C near Santa Catalina and San Clemente Islands and from San Diego south (this study unpubl.; U.S.C.G. 1975).

Much migratory activity was seen in Santa Cruz Basin, near the inter-island channels, and in San Pedro Channel. These areas all harbored large to very large numbers of Sooty Shearwaters, Northern Phalaropes, Arctic Loons and Surf Scoters, many of which rested or fed in the waters close to the northern islands. Most Common and Red-throated Loons, Western and Eared Grebes, and Brant probably passed within 15 km of the mainland coast, rather than farther offshore.

Santa Barbara Channel and the waters of Santa Cruz Basin provided major foraging areas for the nesting species of the northern four islands and San Nicolas and Santa Barbara Islands (Fig. III-217). (These six islands support a large percentage of the seabirds nesting in the study area.) Most of the nesting species - the three cormorants, Brown Pelican, Xantus' Murrelet and Pigeon Guillemot - were found predominantly within 10 km of their colonies, while Cassin's Auklets concentrated from 10-25 km offshore (principally north of their San Miguel Is. colonies).

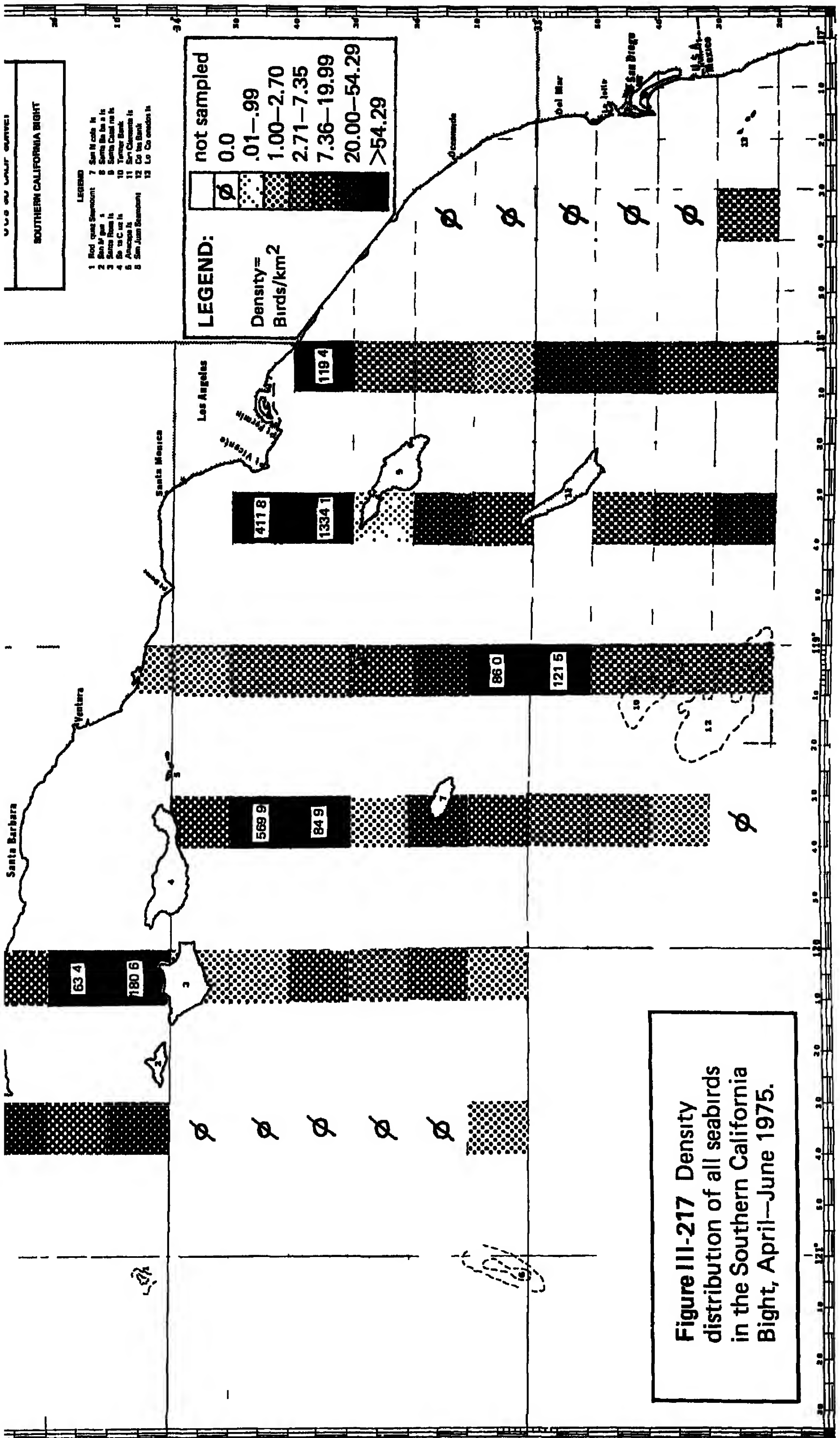


Figure III-217 Density distribution of all seabirds in the Southern California Bight, April–June 1975.

Migrants such as loons, grebes, ducks, and phalaropes were found in the waters east of longitude 118°30'W in moderate numbers and the several species that nest on the eastern islands and Los Coronados were present in low numbers as well. Surprisingly high densities of Xantus' and unidentified murrelets were seen east of San Clemente Is. in May. The intrusion of warm water into this area from May onward (this study unpubl.; U.S.C.G. 1975) correlated with a decline in overall density of birds in June through October.

We did not sample the waters south and southwest of Santa Barbara Is. in April or May. By late June only Sooty and Pink-footed Shearwaters were present there in substantial numbers.

Mainland beaches harbored relatively large numbers of gulls, primarily Western and California, Western Grebes, and Surf Scoters. As was the case throughout the year, the highest total counts of birds were found at the northern (Ventura County) and central (Los Angeles and Orange County) beaches.

Northbound migrants completed their exodus from southern California Waters in the last two weeks of this period.

b. July - September 1975

This was a period of transition from reproductive to migratory and dispersal activities among the nesting residents, and passage out of or through southern California by summer visitors and fall migrants.

Our first representative sampling of waters beyond the continental edge (Patton Escarpment) revealed low overall densities; Sooty Shearwaters and migratory Arctic Terns and Sabine's Gulls accounted for most of the sightings in the deep-water offshore areas.

The greatest numbers of birds were found in Santa Barbara

Channel, Santa Cruz Basin and neighboring waters (particularly those overlying the northern Santa Rosa-Cortés Ridge) and between Santa Barbara Is. and Tanner Bank (Fig. III-218). These were areas in which surface water temperatures varied from 13.5°C to 16-17°C, several degrees cooler than the waters of the Gulf of Santa Catalina (this study unpubl.; U.S.C.G. 1975). The two groups of birds that contributed most heavily to these concentrations were Sooty and Pink-footed Shearwaters and the nesting species.

Because these three months included the nestling, fledging, and dispersal periods of the nesting seasons of several resident species, we observed conspicuous changes in their distribution and behavior. Among the six northern and central islands, nesting birds were rather closely tied to the immediate vicinity of their colonies in July. We did observe foraging Western Gull adults and a few Cassin's Auklets at distances up to 35 km from the nearest colonies but the majority of sightings of both species were much closer to land. The three cormorants, Brown Pelican, and Pigeon Guillemot were only found along the shores of the nesting islands or a few km out to sea. This distribution of foraging activity and of total sightings probably reflects the time-energy budgets of nesting birds, the distribution and availability of food sources, and the necessity of periodic return by parents to colonies to feed young.

We found the greatest total numbers of Western Gulls, Brown Pelicans, and Cassin's Auklets northwest of San Miguel Is., in the eastern end of Santa Barbara Channel, close inshore around all eight islands, and in the waters overlying the northern Santa Rosa-Cortés Ridge and Santa Cruz Basin. Late in the period, fairly large numbers of Western Gulls and Brown Pelicans were found at sea in Santa Monica Bay and San Pedro Channel. Fledging of young Xantus' Murrelets

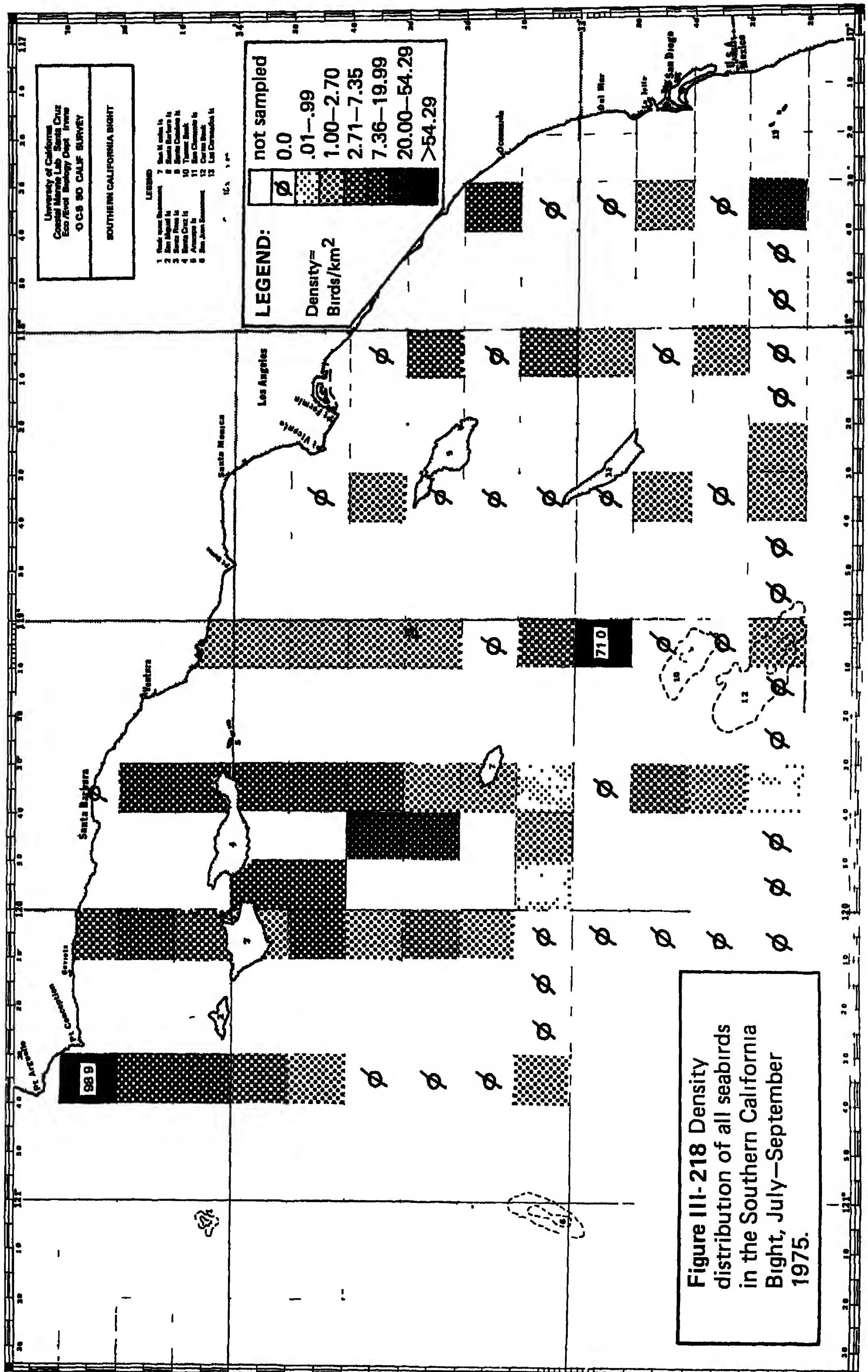


Figure III-218 Density distribution of all seabirds in the Southern California Bight, July–September 1975.

from the sizeable colony on Santa Barbara Is. took place in April and May. We found this species to be virtually absent from the study area from July through December.

In July and early August Sooty Shearwaters massed in great numbers - in some areas hundreds of individuals per km^2 - to the west and northwest of San Miguel Is., south of Santa Rosa and Santa Cruz Is., (where birds streamed by the thousands), and in open water along the Santa Rosa-Cortés Ridge, Santa Cruz Basin and near Tanner Bank. Apparently, either there was a continual influx of birds from outside the Southern California Bight or many birds spent the summer months in the area.

Major changes in distribution and species composition of the avifauna took place in late August and September. The importance of the northern section of the Santa Rosa-Cortés Ridge and Santa Cruz Basin as an area of tremendous concentrations of seabirds (and cetaceans and pinnipeds as well) declined progressively through August, reflecting a decline in shearwater abundance. Instead, many species concentrated near Tanner and Cortes Banks in late September. This area harbored major concentrations of Sooty Shearwaters in early August (this species became progressively less abundant in September), Leach's and Black Storm-Petrels in both August and September, and Western Gulls throughout this period. It was this area (along with the region between San Miguel Is. and Rodriguez Seamount) in which southbound migrants such as Northern Phalaropes, Pomarine Jaegers, Sabine's Gulls, and Arctic Terns, together with rarities such as the South Polar Skua and Black-footed Albatross were found in the greatest numbers.

The open-ocean waters of the Gulf of Santa Catalina again

harbored relatively few birds. Surface water temperatures reached the yearly high in this period; temperatures of 20°C were recorded in several spots in the Gulf, while 150 km to the northwest (near San Miguel Is.) the water was 3° to 7°C cooler (this study unpubl.; U.S.C.G. 1975). Migratory shorebirds such as Whimbrels (Numenius phaeopus), dowitchers (Limnodromus, sp.) and phalaropes, in addition to scoters, were seen passing southeast through this area in September. As in the preceding several months, storm-petrels were found near Fortymile Bank, southeast of San Clemente Is. This area is well known for concentrations of pelagic birds from August through October (McCaskie 1968, 1970, 1972, 1974).

Throughout the summer months the mainland beaches that were censused harbored many hundreds of Western, Ring-billed and California Gulls.

Numbers of several of the species that dispersed northward into southern California (Brown Pelican, Heermann's Gull, Elegant Tern) peaked on mainland beaches in August and September, as did counts of Double-crested Cormorants and Caspian Terns. Small numbers of Western Grebes and Surf Scoters appeared at Mugu Lagoon in these months, indicating the onset of southward migration.

c. October - December 1975

Fall migration extended through October and November. By the end of November most winter residents of the Southern California Bight were present in large numbers and the species that entered the area some months earlier from Mexican waters began to return to the south. Nesting residents of the Channel Islands either remained in the vicinity of their colonies (the three cormorants, Brown

Pelican, Western Gull), dispersed to open-ocean waters and the mainland - still within the study area - (Brown Pelican, Western Gull, Cassin's Auklet), or left the study area (Pigeon Guillemot, Xantus' Murrelet). The winter ranges of the last two species and the Ashy Storm-Petrel are poorly understood.

Shearwaters were almost absent in these months. We detected only southwestward migratory movements of Sooty Shearwaters, lending credence to the proposal of Pyle and DeLong (1968 ms) that the autumn migration of this species off California consists of birds from the nesting populations of the southwestern Pacific.

Bird density was very high throughout Santa Barbara and San Pedro Channels (Fig. III-219). Fewer birds were found elsewhere inshore of the Santa Rosa-Cortés Ridge and density was very low in the oceanic waters beyond the Patton Escarpment. The primary contributors to the high densities in the channels included Western, Bonaparte's and California Gulls, and Brown Pelicans. The latter two gulls were found in moderate to low densities in offshore areas as well. Large numbers of Western Grebes concentrated in the eastern end of Santa Barbara Channel and in inshore waters south along the mainland to San Diego.

Very large numbers of Brown Pelicans were found in these months on roosts throughout the islands. Most of these were found on the northern islands in October. A shift southeastward occurred in November (detected primarily at sea), concurrent with rough weather west of Santa Cruz Is. It is not clear whether the heavy seas and northwest winds of mid-November were the main causative factor

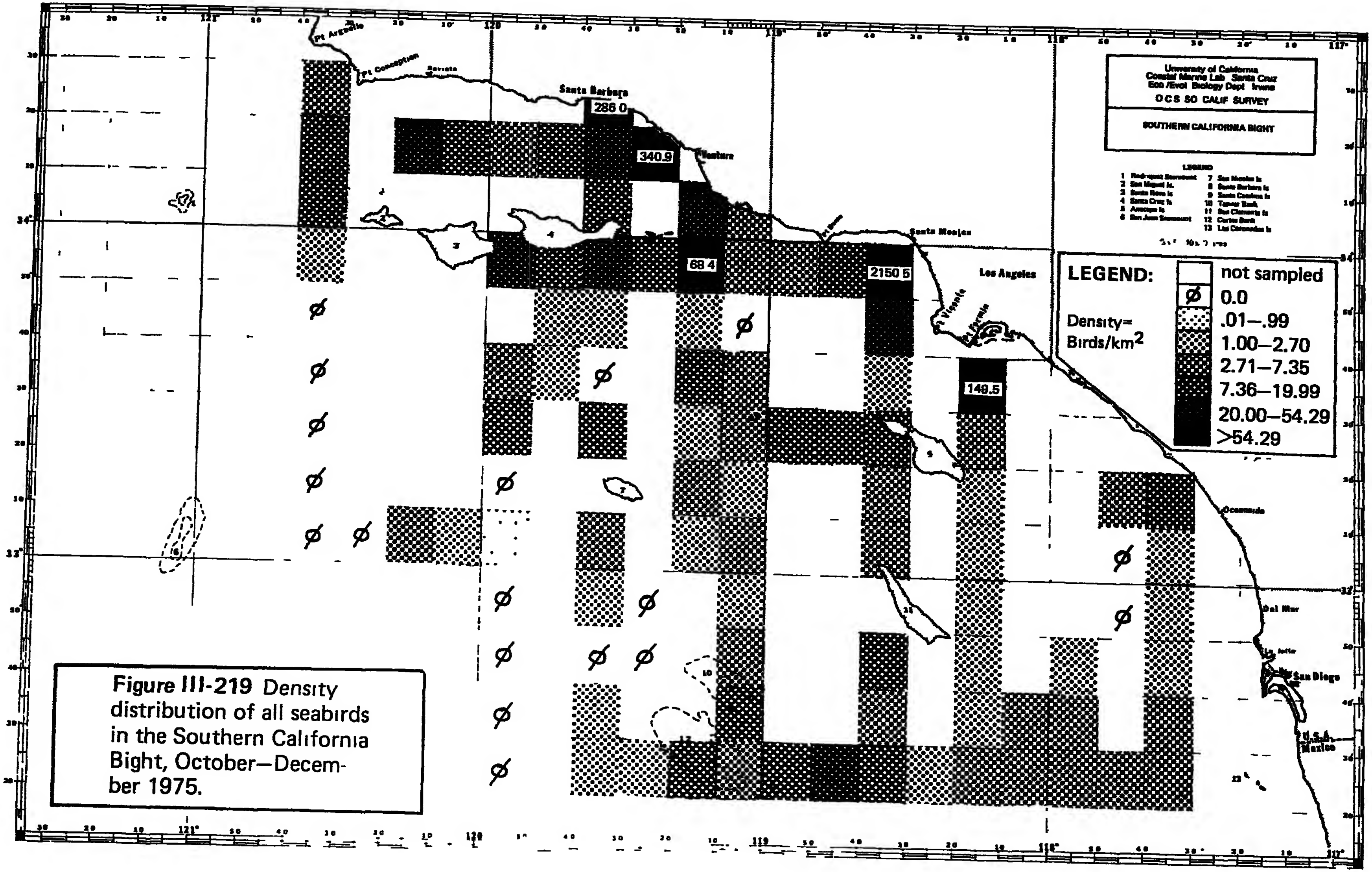


Figure III-219 Density distribution of all seabirds in the Southern California Bight, October–December 1975.

in this shift, however, in that the majority of the pelicans from Mexican colonies pass southward through and out of the study area by the end of December (Anderson and Anderson 1976).

Counts of several other species onshore among the islands reached their yearly peaks in those months. Many thousands of Brandt's Cormorants were found at roosts in October, primarily on the northern islands and at San Nicolas Is. Royal Terns were common at Santa Rosa, Santa Cruz, and San Clemente islands (Table III-130).

Counts of birds along mainland beaches indicated that a number of winter-resident species were moving into the area. Among these were Arctic and Red-throated Loons, Western and Eared Grebes and Surf Scoters, all of which are known for their vulnerability to contamination by floating oil in nearshore waters (see Pages III-727-756 for data and discussion of seabird mortality in southern California). All of these species became more abundant along mainland beaches as the winter progressed.

Several species that predominated in the open-ocean waters of the study area in winter were not yet numerous in October and November. We recorded few Northern Fulmars, Black-legged Kittiwakes or Rhinoceros Auklets in these months. Common Murres were uncommon and restricted to the vicinity of Santa Barbara Channel.

d. January - March 1976

The winter of 1976 was notable for its extremely mild weather: very few fronts pushed through the area, rainfall was scant, and winds and sea conditions were moderate to light throughout the months of December through March. Surface water temperature varied from 11° to 13.5°C., depending on location (U.S.C.G. 1975). In general,

Table III-130.

Frequency of sightings of all species combined (total individuals)on and near Channel Island beaches, April 1975 through March 1976. Numbers in parentheses refer to specific locations on Figures III-178 through -185. Dash indicates area not surveyed or survey incomplete.

Location / Date→ / Type→	Apr-Jun 75	Jul-Sep 75	Oct-Dec 75	Jan-Mar 76					
SAN MIGUEL IS.									
Richardson Rk. (103)	102	233	179	93					
West (102,110-20,160,170)	1427	1313	1541	810					
South (146-51)	304	194	372	216					
East (101,140-45)	1846	894	2028	755					
North (121-40)	130	272	277	281					
SANTA ROSA IS.									
West (611-12,625)	289	288	1563	633					
South (620-24)	80	116	613	2756					
East (618-19,629)	437	653	626	1136					
North (610,613-17)	691	822	817	546					
SANTA CRUZ IS.									
West (641,658)	163	274	749	186					
South (650,653-56)	230	442	783	1454					
East (649,651)	375	356	928	173					
North (640,643-48)	582	448	632	502					
ANACAPA IS. (660-80)	1865	-	-	7482					
SAN NICOLAS IS.									
Northwest (210-60)	140	578	1756	1513					
Southwest (203)	69	25	78	95					
Southeast (202)	37	0	1608	944					
Northeast (201)	127	477	302	416					
SANTA BARBARA IS.(300-330)	1187	597	2141	813					
SANTA CATALINA IS.									
Northwest (506-07,515, 525-27)	11	63	103	852					
Southwest (503-05,529)	103	40	120	1171					
South (502,523-24)	56	13	24	94					
East (501,509-11)	54	54	34	1620					
Isthmus (508,521-522)	73	65	41	1096					
SAN CLEMENTE IS.									
Northwest (409-11)	303	571	790	2141					
West Central (406-08)	66	130	611	579					
Southwest 404-05)	18	42	161	107					
Pyramid Cove (402-03)	10	29	40	0					
East 401,412)	30	0	0	16					

the density of seabirds throughout the study area reached its high point in January, reflecting a tremendous influx of birds from northern and inland nesting areas (Fig. III-220). Several geographic areas had very high bird densities: Santa Barbara Channel, Santa Monica Bay, the entire Santa Rosa-Cortes Ridge, and inshore waters along the Los Angeles, Orange and San Diego County coasts. Moderate numbers of birds were found almost everywhere else, except well offshore beyond the continental margin where total densities were comparatively low.

The major concentrations in open water were comprised of two different assemblages of species. The majority of birds in eastern Santa Barbara Channel consisted of Arctic Loons, Western Grebes, California and Western Gulls and Common Murres. These species, along with Bonaparte's Gulls also predominated in Santa Monica Bay and San Pedro Channel. Each of these areas is rather close to the mainland and has a shallow seabed.

On the other hand, the concentrations encountered on the northern Santa Rosa-Cortes Ridge, near Tanner and Cortés Banks, and at Santa Catalina Is. were mainly Northern Fulmars, Black-legged Kittiwakes, California and Western Gulls, and Cassin's and Rhinoceros Auklets. The main attractant in the first and last of these three areas was apparently squid spawning activity. The great majority of birds seen more than 20 km off the mainland throughout the winter was of these latter species.

The winter of 1976 was clearly one of high relative abundance of Northern Fulmars and Black-legged Kittiwakes; both species are known for considerable variation in year-to-year abundance. (Rhinoceros Auklets may fit this description as well, but little information

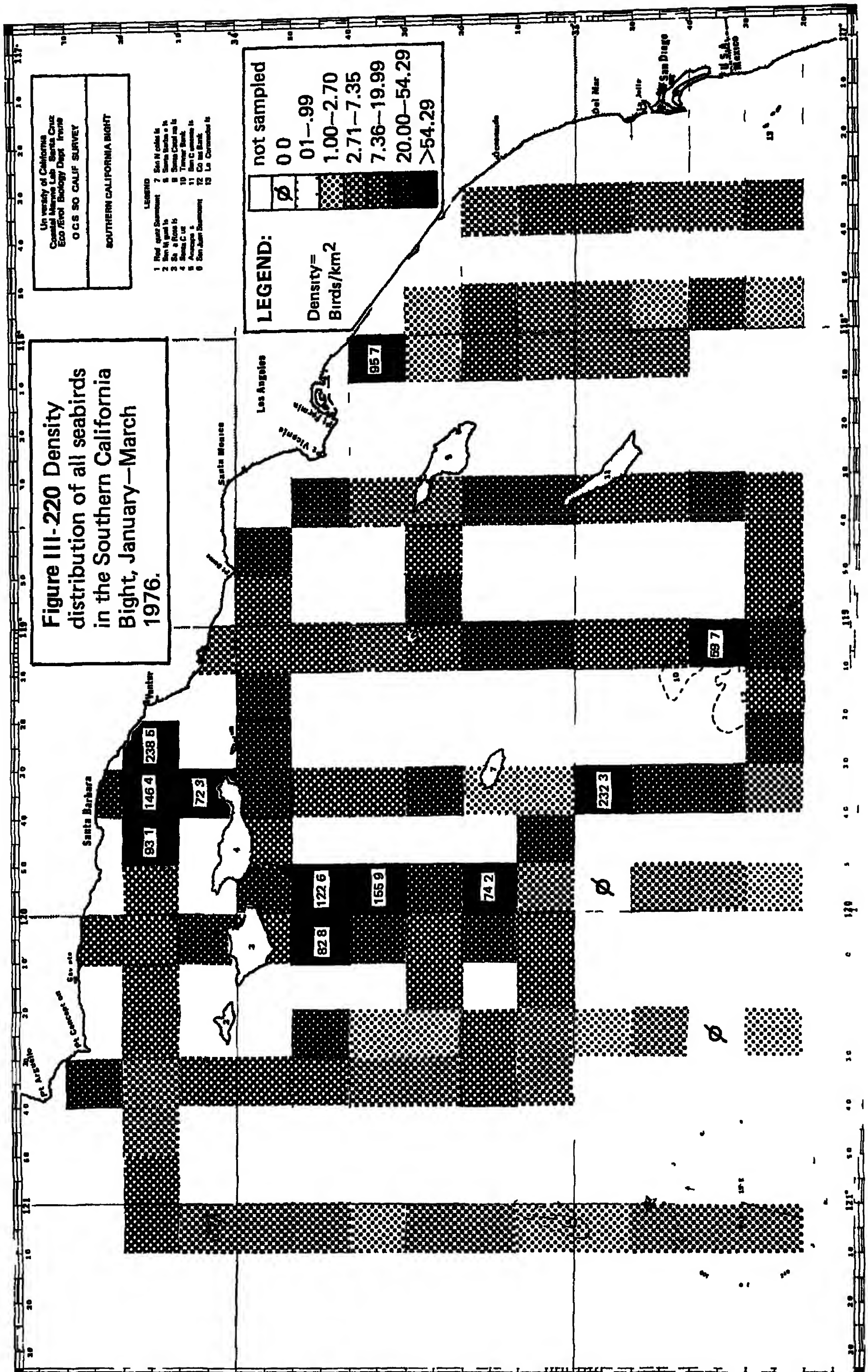


Figure III-220 Density distribution of all seabirds in the Southern California Bight, January—March 1976.

exists about their wintering habits in southern California waters). Interestingly, Cassin's Auklets declined in number with increasing distance from San Miguel Is., while the larger Rhinoceros Auklet was most abundant in offshore waters more to the south and was even found in large numbers east and south of San Clemente Island.

Birds were moderately abundant everywhere east of longitude 118°30'W at distances of 10 to 90 km off the mainland. Kittiwakes, Northern Fulmars, and Rhinoceros Auklets predominated here and were replaced by loons, Western Grebes, and several species of gulls (Western, California, Ring-billed, Bonaparte's) in waters closer to the coast.

Relatively large numbers of Brandt's Cormorants and Western and California Gulls were found on Channel Is. roosts in January through March. Diving birds (Artic Loon, Eared Grebe, Surf and White-winged Scoters) were also quite common inshore around the northern islands at this time. Owing to distance from land or perhaps oceanographic conditions, the diving birds noted above did not appear in large numbers at San Nicolas, Santa Barbara, or San Clemente islands. Brown Pelicans decreased in number in inshore waters, reflecting the continued southward migration of birds to Mexican colonies.

Numbers of birds on and near mainland beaches were high in the months of January to March. Many of the same species that predominated near the shores of the islands were also abundant along the mainland. Arctic, Common and Red-throated Loons, Eared and Western Grebes, Surf Scoters, and Western, California, Ring-billed and Bonaparte's Gulls were found in large numbers from McGrath State

Beach to Dockweiler State Beach, were somewhat less abundant along Orange Co. shores, and were abundant near San Diego. The latter area is known as a wintering area of great importance for loons, grebes, and diving ducks (J.R. Jehl, Jr. pers. comm.).

In March we detected a general decrease in abundance and concurrent shift toward northern areas (Santa Monica Bay, Pt. Mugu, eastern Santa Barbara Channel) among the species that were most abundant along the central and southern beaches. No such relocation appeared to occur among the species that were found farther offshore until several months later.

e. Avian vulnerability relative to offshore resource development

The ecological situations and geographical settings that deserve special attention prior to and during the development of offshore oil resources are those in which significant concentrations of especially vulnerable bird species have been recorded. Vulnerable populations are ones that -- by reason of their food-getting habits, reproductive status, population size and distribution, or their tendency to aggregate -- might be seriously affected by spillage of oil or disturbance of nesting. For reasons discussed elsewhere in this paper and in the accompanying paper on beached bird studies we may expect all of the species that nest among the Channel Islands, and all loons, grebes, scoters, phalaropes and alcids to be particularly susceptible to such potential impacts. Fulmars, shearwaters, storm-petrels, and pelagic gulls (Black-legged Kittiwake, for example) may also be seriously affected, but probably to a lesser degree than the above

groups of birds.

The following summary of our 1975-76 observations may then serve to identify the areas and seasons in which major aggregations of these vulnerable marine birds occurred.

Consistently elevated avian densities (all species combined) were centered in zones of shallow water throughout the study (such as in channels and over banks and escarpments), near shore around all islands, and along mainland beaches. The distribution pattern of these high-density centers shifted somewhat with the seasons, but Santa Barbara Channel, the vicinity of the northern Channel Islands, the northern Santa Rosa-Cortés Ridge, Santa Monica Bay, San Pedro Channel, Tanner, Cortés and Fortymile Banks were areas of high activity all year. Santa Cruz Basin was a primary foraging area for nesting species in April - May, as were inshore waters around all the Channel Islands. Northbound migrants such as loons, grebes, ducks and phalaropes predominated in Santa Barbara and San Pedro Channels.

Sooty (and Pink-footed) Shearwaters and other summer residents were responsible for a sharp increase in avian density in June - July in the northwestern sector of the Bight. Throughout the summer, the great majority of sightings of all nesting species occurred within 20 km of the four northern islands, San Nicolas and Santa Barbara Islands. The southeastern sector from Tanner-Cortes Bank to the mainland harbored large numbers of shearwaters, storm-petrels and southbound migrants during August - September.

Winter residents, such as gulls, pelicans, shorebirds and diving birds (loons, grebes, duck, alcids) gathered in tremendous

numbers in Santa Barbara and San Pedro Channels, Santa Monica Bay, around the northern islands, and along mainland beaches in October - December; fulmars, kittiwakes, gulls and auklets predominated in offshore areas including the Santa Rosa-Cortés Ridge and Tanner and Cortés Banks in January. This pattern held throughout February and March.

In summary, the data presented in this report characterize the numbers, distribution and seasonal dynamics of seabirds that utilized the waters of the Southern California Bight in 1975-76. These data are far more comprehensive than any previously available, allowing comparison of different taxa in different areas throughout the year. The major changes that have taken place in numbers and distribution of nesting birds may be ascertained by comparing present data with accounts in the literature; this is largely not possible for non-resident species and for the nesting species away from their colonies due to the paucity of relevant, quantitative, historical information.

It is clear that great differences existed in 1975-76 between the total numbers of birds present in shallow, cool-water, upwelling areas such as Santa Barbara Channel, near Pt. Conception, and the Santa Rosa-Cortés Ridge and those in warm water, inshore areas such as the Gulf of Santa Catalina and (seasonally) Santa Monica Bay. It is likely that large scale geographical and seasonal differences in bird density within the Bight will persist from year to year. We may also expect to find, however, that there may be considerable yearly variation in species composition and relative abundance in certain portions of the Bight.

Clearly, long-term studies of similar nature and methodology as the present one will be required to understand the nature and extent of such year-to-year variation.

SECTION IV
SEABIRDS

Chapter II
Seabird Reproductive Ecology

H. L. Jones and G. L. Hunt, Jr.

III. BIRDS: Seabird Reproductive Ecology

A. Introduction

As a part of the first year of baseline studies of marine birds in relation to the development of outer continental shelf oil resources, we examined the reproductive ecology of the seabirds nesting in the Channel Islands of California. Although these islands are close to metropolitan Los Angeles, relatively little was known of the reproductive ecology of the seabirds nesting there. The purpose of the present study was to obtain data on timing of reproduction, reproductive success and growth rates of each nesting seabird species.

The study of reproductive ecology is of critical importance for a baseline study of marine birds prior to offshore oil development. While the vast bulk of attention has been drawn to dramatic kills of seabirds subsequent to oil spills (see Vermeer and Vermeer 1974 for an annotated bibliography through 1973), sublethal effects of oil may have a profound effect on populations by severely diminishing reproductive output.

Sublethal oiling may affect reproduction of waterfowl in several ways. Hartung (1965) and R. Grau (pers. comm.) have shown that ingested oil may cause cessation of laying, and R. Grau (pers. comm.) has found that oil will disrupt yolk structure in Japanese Quail (*Coturnix coturnix*) and Canada Geese (*Anser canadensis*) and

reduce hatchability in the eggs of Japanese Quail. Hatchability of eggs may also be reduced by their becoming coated with oil from the soiled plumage of adults (Rittinghaus 1956, Hartung 1965, O'Connor 1967 in Nelson-Smith 1973). Thus, in an oil-related baseline study, it is essential to document normal levels of hatching success. Without such information, it will be extremely difficult to separate pre-existing causes of hatching failure from the effects of oil subsequent to commencement of oil recovery operations.

Of the nine marine bird species presently known to be nesting, considerable data from the Channel Islands are available for three species (Brown Pelican, Pelecanus occidentalis, Double-crested Cormorant, Phalacrocorax auritus, and Western Gull, Larus occidentalis). In contrast, very little information is available for six species (Ashy Storm-Petrel, Oceanodroma homochroa, Pelagic Cormorant, P. pelagicus, Brandt's Cormorant, P. penicillatus, Pigeon Guillemot, Cepphus columba, Xantus' Murrelet, Endomychura hypoleuca and Cassin's Auklet, Ptychoramphus aleuticus).

The Brown Pelican, due to its sensitivity to various chlorinated hydrocarbons, has been the subject of numerous recent studies (Anderson et al. 1975, Jehl 1973a, Keith et al. 1971, Risebrough 1972, Risebrough et al. 1971, Anderson and Hickey 1970, Gress 1970, McCaskie 1970e, Schreiber and DeLong 1969). Anderson et al. (1975) document reproductive success of pelicans on Anacapa and Santa Cruz Islands and Is. Coronado Norte from 1969 through 1974. Although they show that reproductive success in this species is improving, the pelican population in southern California has been in a continuing decline since the mid-1950's (Anderson and Anderson 1976). Year-to-year

fluctuations in the numbers of Brown Pelicans off our coast are apparently closely tied to changes in water temperature influencing the abundance of their major food fish, the northern anchovy (*Engraulis mordax*). The long-term changes in population size are almost certainly the result of reproductive failure caused by chlorinated hydrocarbons in the environment (Anderson et al. 1975, Anderson and Anderson 1976). The recent improvement in Brown Pelican reproduction off the California coast may reflect not only years of increased anchovy abundance, but also a decline in the levels of chlorinated hydrocarbon pollutants (Anderson et al. 1975). In 1975, pelican reproductive output on Anacapa Is. was just slightly better than that found in 1974 (Anderson et al. in press).

Double-crested Cormorants have been shown in two studies to be declining in southern California, apparently due to the effects of chlorinated hydrocarbon pollution (Gress et al. 1973, Anderson et al. 1969). Gress et al. (1973) provide a detailed examination of changes in eggshell characteristics since the late 1940's. They provide data on reproductive success as follows:

Colony	Year	Number of nests	Number of young produced
Is. Coronado Sur	1969	32	1
Is. Coronado Sur	1970	30	0
Is. Coronado Sur	1971	5	0
West Anacapa Is.	1969	79	0
West Anacapa Is.	1970	50	3
West Anacapa Is.	1971	48	0
West Anacapa Is.	1972	11+	5

At present, D. Ainley of the Point Reyes Bird Observatory is working on a broad-scale study of the food habits of this fish-eating species along the Pacific coast of North America.

Western Gull breeding biology in southern California is relatively well known. Studies by Schreiber (1970) on San Nicolas Is. and Harper (1971) on Bird Rk., Santa Catalina Is., provide general overviews of Western Gull reproductive ecology. On Santa Barbara Is., Hunt and Hunt (1973, 1975, 1976a), Hunt and Hunt (ms) and Hunt, Hunt and Risebrough (ms) provide detailed studies of clutch size, eggshell thinning, reproductive success, foods brought to chicks and abnormal pairing.

None of the other six species has been the subject of detailed ecological study in southern California. However, ecological data are available for most of these species based on investigations conducted in other parts of their ranges. Ashy Storm-Petrels: Ainley et al. (1974 and 1976) provide a wealth of data from the Farallon Islands. Double-crested, Brandt's and Pelagic Cormorants: Robertson (1971) and van Tets (1965) contribute interesting comparative data. Cassin's Auklets: the studies of Manuwal (1974a, b), Speich and Manuwal (1974) and Thoresen (1964) provide particularly useful comparative material on auklet nesting on the Farallon Islands. Pigeon Guillemots: Drent's (1965) detailed work on their nesting on Mandarte Is., British Columbia, provides a basis for comparison. Xantus' Murrelets: there is virtually no recent ecological literature on this species, and the present study represents the first detailed work on their breeding biology since the publication of Bent (1919). The work of DeWeese and Anderson (1976)

on the closely related Craveri's Murrelet (E. craveri) of the Gulf of California should prove most useful for comparison.

The present study, then, was designed to gather information on seabird reproductive ecology that would supplement information already available in the literature for the lesser known species and which would add to the already established data base for the Western Gull and Double-crested Cormorant. No attempt was made to obtain data concerning Brown Pelican nesting efforts since their status as an endangered species rendered their nesting islands off-limits.

This paper includes results of work up to December 31, 1975. Data gathered during colony surveys in January, February and March 1976 will be reported with the results of the 1976 contract.

B. Methods

1. Field schedule

In order to gain data on timing of nesting, reproductive success, growth rates and food habits, we planned a series of visits at three- to four-week intervals to each of the islands where seabirds were known or suspected to nest (Table III-131). In addition, we planned one 7-8 day trip each to Santa Barbara and San Miguel islands for the purpose of radio-tracking foraging birds (discussed elsewhere). The actual number of visits to each islands, however, was considerably less than the planned schedule, due both to unusually rough weather and boat breakdowns (Table III-132). As a result, we obtained less than a satisfactory amount of data on reproductive ecology in 1975.

On Santa Barbara Is. we were able to obtain more complete data than elsewhere. As part of an independent study project at the

Table III-131. Planned island surveys for seabirds, 1975.

Trip No.	Anacapa	Santa Cruz & Santa Rosa	San Miguel	San Nicolas	Santa Barbara	Santa Catalina	San Clemente
1	10 Apr	11 Apr	12 Apr	13 Apr	14 Apr	15 Apr	-
2	10 May	11 May	12 May	13 May	14 May	-	15 May
3			End radio track 5 June		Start radio track 20 May		
4	20 Jun	21 June	22 Jun	23 Jun	24 Jun	25 Jun	-
5	15 July	16 July	17 July	18 July	19 July	-	20 July

Table III-132. Island visitation. The number of hours spent in the field on each island is given in parenthese following the date of visit.

San Miguel	Santa Rosa	Santa Cruz	Anacapa	San Nicolas	Santa Barbara	Santa Catalina	San Clemente
13 May(16)	18 Apr (2)	18 Apr (7)	17 Apr (1)	20 Apr (5)	19 Apr (6)	20 June (2)	8 May (4)
14 May(10)	14 July(1)	16 June(4)	16 June(4)	11 June(6)	20 Apr (12)	17 July (1)	18 July(7)
28 May(11)		14 July(4)	14 July(4)	19 June(7)	21 Apr (7)		
29 May(12)				17 July(5)	9 May (11)		
30 May(12)					10 May (5)		
31 May(12)					20 May (3)		
1 June(12)					21 May (12)		
2 June(12)					22 May (12)		
3 June (6)					23 May (12)		
18 June(7)					24 May (12)		
14 July(2)					25 May (12)		
15 July(10)					26 May (12)		
					27 May (7)		
					7 June (4)		
					8 June (4)		
					20 June (6)		
					16 July (5)		
Total hours							
(122)	(3)	(15)	(9)	(23)	(142)	(3)	(11)

Note: The visits of 20 May - 27 May at Santa Barbara Island (82) hours and 28 May - 3 June at San Miguel (77) hours were for the purpose of radio-tracking and full time was devoted to that task.

University of California, Irvine, M.W. Hunt and five undergraduates, S. Anthony, Z. Eppley, P. Ewald, L. Holmgren and D. Schwartz, camped on the island from 10 April until 28 May. Two students remained on Santa Barbara Is. until mid-July. This group, although not supported by the Bureau of Land Management study, has made their data availabled for inclusion in this report.

2. Timing of breeding

Data on phenology were obtained during each visit to an island. Nests were marked with numbered stakes on the first visit and they were inspected and their contents recorded on that and all subsequent visits. Cormorant nests were not marked, but the location of individual nests was mapped. On Santa Barbara Is., the resident study group visited Western Gull nests daily to record timing of egg laying. Nests of Xantus' Murrelets were checked once every other day in order to determine timing of hatching. Egg laying by the murrelets took place before the group arrived on the island.and since the incubation period is presently unknown, we do not have the means of estimating laying dates for the murrelets. However, we have searched the literature and museum egg collections and made use of data assembled by L. Kiff of the Western Foundation of Vertebrate Zoology on dates of egg collections in the Channel Islands in order to obtain estimates of the duration of the nesting season of each species.

3. Reproductive success

Reproductive success was determined on the basis of the number of eggs hatching and the number of young fledging or surviving until an age appropriate for fledging. In the case of Western Gulls, the

number of young surviving to 500 g was used as a criterion for survival (Hunt 1972, Hunt and Hunt 1975). It is often useful to use a criterion other than fledging for chick survival as it is difficult to determine the actual time of fledging for most species and for some, such as the Xantus' Murrelet, determination of fledging is inappropriate. The young murrelets go to sea one to two days after hatching, well before they can fly.

4. Growth rates

To obtain growth rate data, young were banded and weighed. For weighing, Pesola spring scales were used with an accuracy of $\pm$ 1-25 g, depending upon the capacity of the scale. The accuracy of these scales was within the limits of accuracy imposed by the movements of the birds and the amounts of weight represented by foods they had ingested or the weight of a defecation.

Growth rates of Western Gulls were calculated on the basis of the formula: $\frac{wt_2 - wt_1}{day_2 - day_1}$ for the slope of the straight-line portion of the growth curve (Spaans 1971, Hunt 1972, Hunt and Hunt 1975, 1976a). This straight-line phase of growth occurs roughly between 125 g and 600-700 g. Outside this range, growth is curvilinear.

C. Results

1. Phenology

The following represents a summary of historical data as well as data obtained in 1975 on the timing of nesting of marine birds on the California Channel Islands. Unless otherwise noted, historical data were provided through the courtesy of L. Kiff of the Western Foundation of Vertebrate Zoology. We did not visit Islas los Coronados

in 1975 as they are outside the contract study area, however, historical data for these islands are included for the sake of completeness.

Leach's Storm-Petrel (_Oceanodroma leucorhoa_)

Timing of nesting and clutch size.

Los Coronados historical: Eggs: 30 May-5 September; 154 clutches of one egg each. Most eggs taken in June and July. Chicks: 4 July 1919.

1975 - not recorded on Channel Islands checked.

Ashy Storm-Petrel (_Oceanodroma homochroa_)

Timing of nesting and clutch size.

San Miguel (Prince Is.) historical: Huber (1968) collected 1 egg late May or early June on Castle Rk.

1975 - 13 May, 4 adults came aboard vessel at night; one probable nest located by odor 14 May on Prince Is.

Santa Cruz Is. (Painted Cave) historical: Eggs: 23 June-19 July; chicks: 19 July.

1975 - not recorded.

Santa Cruz Is. (Scorpion Rk.) historical: Eggs: 17 May-10 July; 45 clutches of 1 egg each.

1975 - not checked due to presence of pelicans.

Santa Cruz Is. (Orizaba Harbor) historical: 5 sets of 1 egg each taken 23 May 1937; 3 sets taken 22 May 1938.

1975 - not checked.

Los Coronados historical: 1 clutch of 1 egg taken 20 April 1916.

Black Storm-Petrel (Oceanodroma melania)

Timing of nesting; egg dates and clutch size.

Los Coronados historical: Eggs: 22 May-13 August; 62 clutches of 1 egg each. Most records are for June.

1975 - not recorded on Channel Islands checked.

Brown Pelican (Pelecanus occidentalis)

Timing of nesting and clutch size

San Miguel (Prince Is.) historical: Eggs: 24 March-15 June. 8 clutches, mostly of 3 eggs. Most records from May and June.

1975 - no nests.

Santa Cruz Is. (Scorpion Rk.) historical: No data available.

1975 - 14 July, 8-10 nearly grown downy young.

Anacapa Is. historical: Eggs: 24 February-6 June. 134 clutches, mostly 3-4 eggs. Most records from March. Chicks: 28 March 1927, 5 June 1910, 27 May 1962, 2 March 1917, 13 March 1927, 11 June 1915, 26 May 1917 - fledged 5 June 1910.

1975 - 16 June, young seen in 3 nests.

Santa Barbara Is. historical: Eggs: 4 sets; 1 of 3 eggs, 2 July 1912 and 3 sets, 1 of 2 eggs and 2 of 1 egg, 7 May 1914. Chicks: 31 March 1927.

1975 - no nests.

Los Coronados historical: Eggs: 5 March-22 June. 129 clutches, mostly of 3 eggs. Most records from April and May. Chicks: 26 March 1917, 1 May 1921, 3 April 1921,

23 April 1895.

Double-crested Cormorant (Phalacrocorax auritus)

Timing of nesting and clutch size.

San Miguel (Prince Is.) historical: Eggs: 19 May-15 June. 30 sets, each of 3-4 eggs. Chicks: 6 June 1906.

1975 - 13 May. 3 nests checked, 1 with 1 egg and 1 newly hatched young, 2 with 1 new young; eggs not seen.

Anacapa Is. historical: Eggs: 13 May-17 May, 3 separate collections (1927, 1936, 1969), clutch size 3-4 eggs.

1975 - no data (pelicans present).

Santa Barbara Is. historical: Eggs: 7 May-2 July. Most (36) clutches 3-4 eggs; most commonly collected in May.

1975 - no data obtained from 13 nests.

San Clemente Is. historical: Eggs. Species identification uncertain for this island, location not given, 2 sets of 1 egg each 3 May 1914.

1975 - none found.

Los Coronados historical: Eggs: 28 March-6 June; most clutches 4 eggs; most commonly collected in May. Chicks: 1 May 1921 (most well grown), 27 May 1917.

Brandt's Cormorant (Phalacrocorax penicillatus)

Timing of nesting and clutch size.

San Miguel Is. (Prince Is.) historical: Eggs: 19 May-12 July. Most commonly collected in June; 40 clutches, most containing 3-4 eggs.

1975 - 13 May, 119 nests with incubating adults; 30

nests checked, 21 empty, 9 with eggs; 18 June, 6 chicks, mean weight 1602 ± S.D. 265 g.

Santa Cruz Is. (Gull Is.) historical: Eggs: 3 sets of 4 eggs each 9 April 1939.

1975 - 18 April, 7 nests checked, 4 with eggs (2-4), 3 empty.

Anacapa Is. historical: Eggs: 3 sets, 19 April, 15 May and 27 May; 2 of 4 eggs, 1 of 5 eggs.

1975 - no data obtained.

San Nicolas Is. historical: no data on timing available.

1975 - 20 April, fresh nests; 19 June, 6 chicks, mean weight 1672 ± 171 g.

Santa Barbara Is. historical: Eggs: 27 March-3 July, only 5 separate collections. 10 clutches, most containing 4 eggs.

1975 - 20 June, 4 nests checked, 2 with eggs, 2 with young.

Santa Catalina Is. (unidentified offshore rock) historical: Eggs: one set of 3 and one of 4 collected 11 April 1904.

1975 - none found nesting.

Los Coronados historical: Eggs: 27 March-25 May; most collections April and May. Clutch size: 23 sets, generally 3-4 eggs.

Pelagic Cormorant (*Phalacrocorax pelagicus*)

Timing of breeding and clutch size.

San Miguel Is. (Prince Is.) historical: Eggs: 3 June-

14 June, 6 collections. Clutch size: generally 3 eggs.

1975 - 14 May, one nest checked, 2 large young present.

Santa Cruz Is. (Gull Is.) historical: no records.

1975 - 18 April, 1 nest with adult incubating.

West Anacapa Is. historical: Eggs: no data available.

1975 - 14 July, 1 nest, probably of this species; 3 young.

Western Gull (*Larus occidentalis*)

Timing of nesting and clutch size

San Miguel Is. (Prince Is.) historical: Eggs: 5 May-17 June. In 11 clutches collected between 1905 and 1933, 1 clutch of 4 eggs collected.

1975 - 13 May, 115 nests with eggs; 29 May, 55 nests, 74% with eggs, 13% with eggs and chicks, 13% with only chicks; 18 June, 50 nests, 2% with eggs, 4% with eggs and chicks, 92% with only chicks. 2% of nests contained 4 eggs.

Santa Cruz Is. (Gull Is.) historical: no data available.

1975 - 18 April, of 31 nests, 30% fresh scrapes, 1% with eggs.

Santa Cruz Is. (Scorpion Rk.) historical: Eggs: 17 May-3 June. In 18 clutches collected between 1928 and 1939, no clutches greater than 3 reported.

Anacapa Is. historical: Eggs: 6 May-6 June; in 85 clutches collected between 1899 and 1969 no clutches greater than 3 reported.

1975 - 16 June, 18 nests, 2% with eggs, 1% with eggs and chicks, 15% with only chicks; 30 chicks, mean weight 531 ± 118 g.

San Nicolas Is. historical: one set of 3 eggs taken 3 June 1891; Schreiber (1970): in 1968, 11.3% of clutches greater than 3 eggs; R. Lust (in lit.) in 1973 estimated 11-15% of the nests contained 4 eggs.

1975 - 29 April, 15 fresh scrapes; 11 June, 55 nests, 16 with eggs, 3 with eggs and chicks, 36 with only chicks; 19 June, 24 nests, 1% with eggs, 23% with only chicks. 19 June, 56 chicks, mean weight 537 ± S.D. 159 g.

Santa Barbara Is. historical: Eggs: 5 May-2 July, for 1973 see Fig. III-221. In 60 clutches collected between 1897 and 1928 no clutches of more than 3 eggs reported. Hunt and Hunt (1973). 1972, 11% nests with more than 3 eggs. Hunt and Hunt (unpubl. 1973) 7.7% clutches with more than 3 eggs; 1974 13.8% with more than 3 eggs.

1975 - see Fig. III-222 fordata on clutch initiation. Distribution of clutch size in 126 nests. C/1, 4.8%; C/2, 21.4%; C/3, 63.5%; C/4, 3.2%; C/5, 7.1%. 20 June, 28 chicks, mean weights 318 ± S.D. 127 g.

Santa Catalina Is. (Bird Rk.) historical: Eggs: 5 May-27 May. In 13 clutches collected between 1908 and 1928, no clutches of more than 3 eggs reported.

1975 - 20 June, 18 chicks, mean weight 595 ± S.D. 116 g;

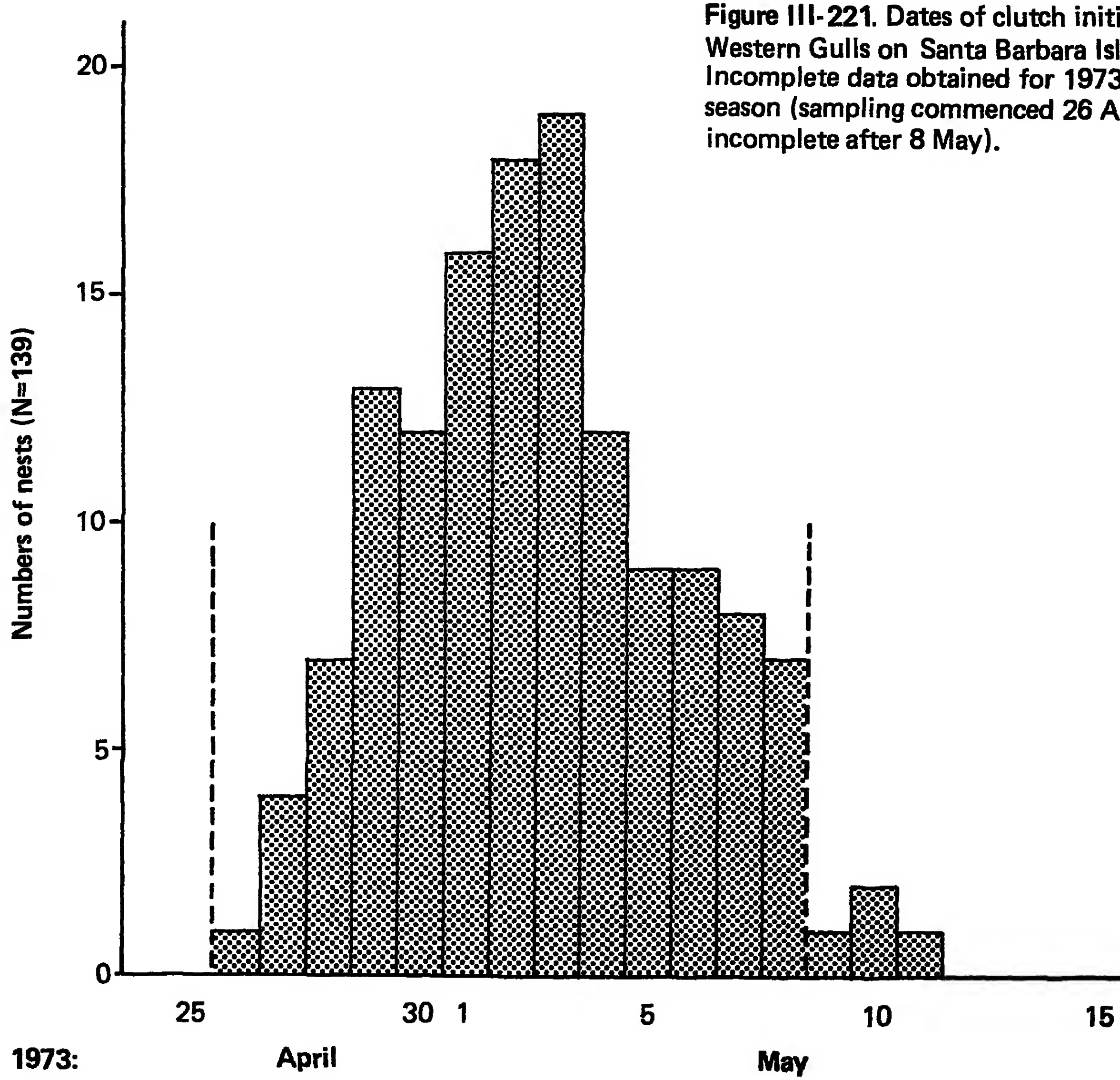
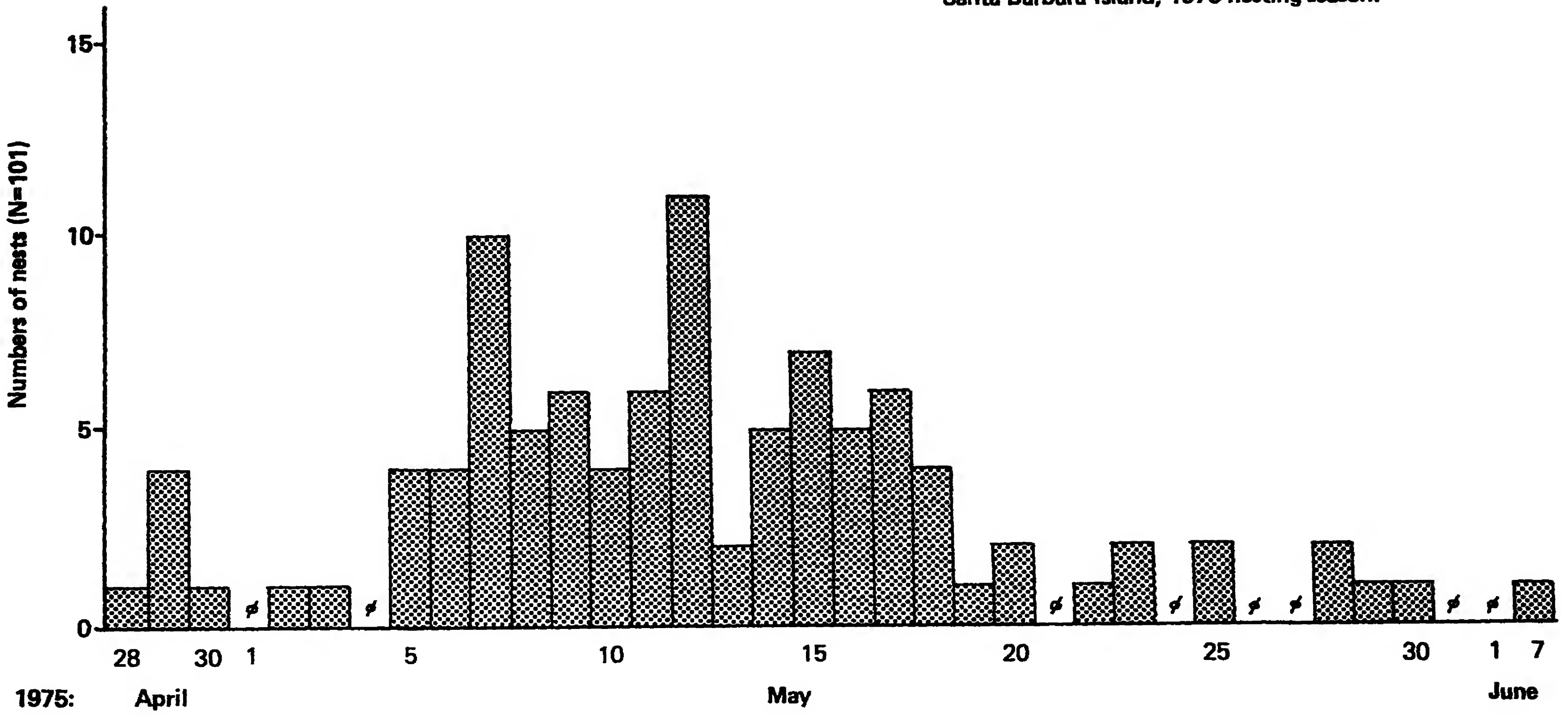


Figure III-221. Dates of clutch initiation by Western Gulls on Santa Barbara Island. Incomplete data obtained for 1973 nesting season (sampling commenced 26 April, incomplete after 8 May).

Figure III-222. Dates of clutch initiation by Western Gulls on Santa Barbara Island, 1975 nesting season.



17 July, all chicks fledged.

San Clemente Is. (Bird Rk. in NW Harbor) historical:

1 set of 3 eggs collected at San Clemente 3 May 1914.

1975 - 8 May, 31 nests, 10% fresh scrapes, 90% with eggs.

Los Coronados historical: Eggs: 24 April-5 June. In 148 clutches collected between 1894 and 1941, one set of 4 eggs was found in 1917.

Common Murre (*Uria aalge*)

Timing of nesting and clutch size.

San Miguel Is. (Prince Is.) historical: Eggs: 5 June-12 July. 82 sets mostly in June; clutch size - 1 egg.

1975 - no nests or adults present.

Pigeon Guillemot (*Cepphus columba*)

Timing of breeding and clutch size.

San Miguel Is. (Prince Is.) historical: Eggs: 9 June-23 June; 4 records. Clutch size: 4 sets of 2 eggs each.

1975 - no data on reproductive ecology.

Santa Cruz Is. historical: Eggs: 3 sets, 26 May, 24 June and 10 July. Clutch size: 3 sets, 2 eggs each. Chicks: 10 July 1912, numerous nests with 1 young each.

1975 - no data on reproductive ecology.

Anacapa Is. historical: Eggs: 14 May-22 June; 7 records, 6 from May. Clutch size: 5 sets of 2 eggs, 2 sets of 1 egg. Chicks: 26 May 1917; 3 nests with 2 chicks each and 1 nest with 1 egg.

1975 - no data on reproductive ecology.

Santa Barbara Is. historical: Eggs: 1 set of 2 eggs 15 May 1897.

1975 - no data on reproductive ecology.

Xantus' Murrelet (Endomychura hypoleuca)

Timing of breeding and clutch size.

San Miguel Is. (Prince Is.) historical: no good data.

1975 - 13 May, 1 nest found with 1 egg.

Santa Cruz Is. (Scorpion Rk.) historical: Eggs: 17 May-25 May. Clutch size: 9 sets of 2 eggs each; 1 set of 1 egg. Chicks: 20 May 1928 - pipped eggs.

1975 - not checked due to pelican nesting.

Anacapa Is. historical: Eggs: 11 May-5 July. Most records for May. Clutch size: 14 sets of 2 each, 6 sets of 1 egg, 1 set 2 eggs plus 1 broken egg.

1975 - no nests found.

Santa Barbara Is. historical: Eggs: 1 set of 1 egg, 3 July 1912.

1975 - see Fig. III-223for hatching distribution.

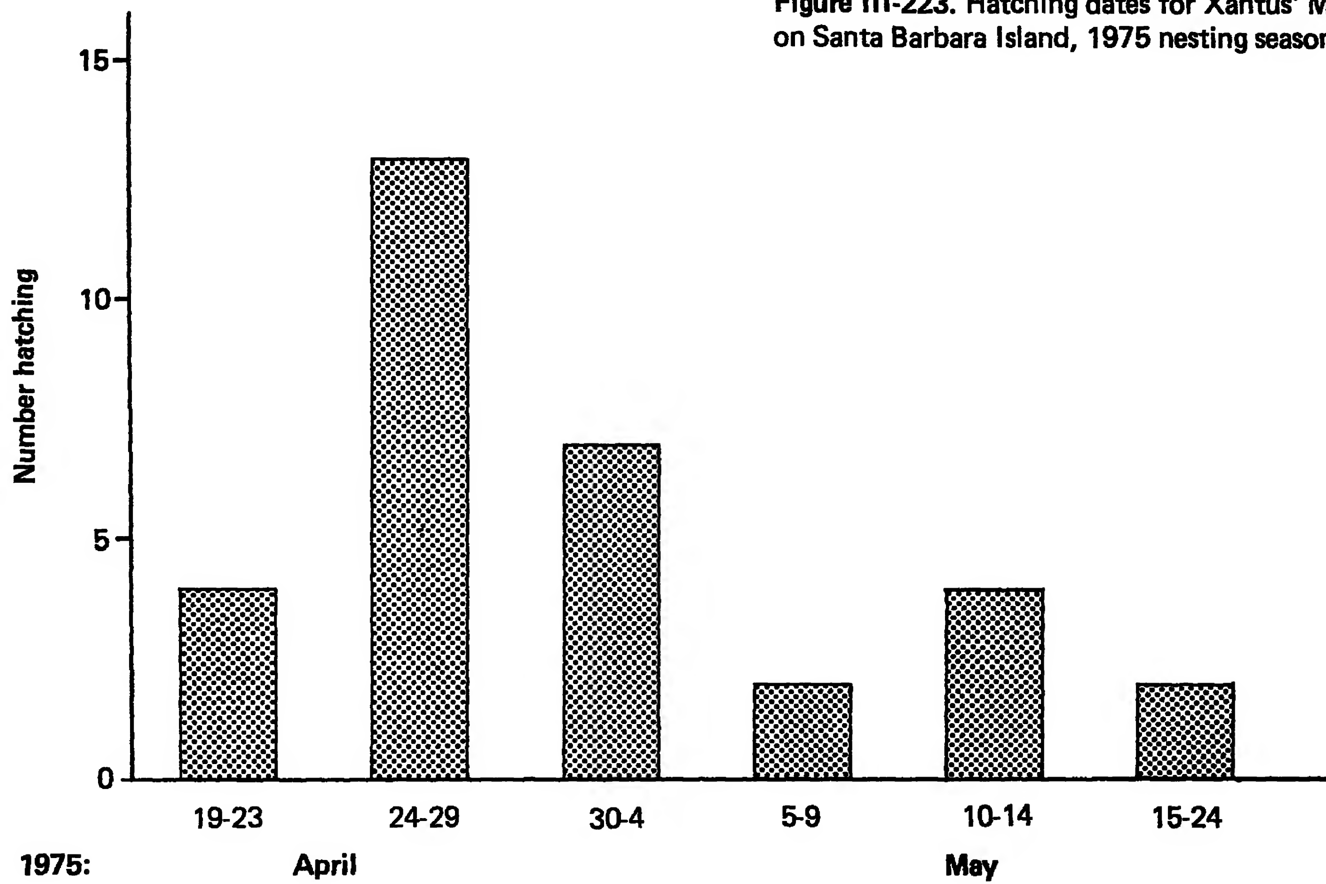
Los Coronados historical: Eggs: 5 April-6 July; most records in May. Clutch size: 82 sets of 1 egg each, 286 sets of 2 eggs each, 4 sets of 3 eggs each and 3 sets of 4 eggs each.

Cassin's Auklet (Ptychoramphus aleuticus)

Timing of nesting and clutch size.

San Miguel Is. (Prince Is.) historical: Eggs: 31 March-15 June. Most records in June. Clutch size: 1 egg. Chicks: 15 June 1910, half-grown young.

Figure III-223. Hatching dates for Xantus' Murrelets on Santa Barbara Island, 1975 nesting season.



1975 - 13 May, 27 nests checked, 9 with eggs, 16 had chicks, mean weight 128 ± S.D. 40.5 g; 29 May, 2 chicks still present.

Santa Cruz Is. (Gull Is.) historical: no records.

1975 - 18 April, 8 nests checked, 6 had eggs, 1 had a chick.

Santa Cruz Is. (Scorpion Rk.) historical: Eggs: 3 records 20 March, 8 April and 20 May. Clutch size: 1 egg.

Santa Barbara Is. historical: Eggs: 16 May-June; 2 records for May, 3 for June. Clutch size: 1 egg.

1975 - not found.

Los Coronados historical: Eggs: 23 March-8 June; most records in April and May. Clutch size: 1 egg.

Tufted Puffin (*Lunda cirrhata*)

Timing of nesting and clutch size

San Miguel Is. (Prince Is.) historical: Eggs: 5 June-15 June. 4 dates. Clutch size: 1 egg.

1975 - not nesting, no adults present.

Santa Cruz Is. historical: no data available.

1975 - not found.

2. Growth rates

Growth rate data were obtained by the BLM team for Western Gull chicks on Prince Is. and San Nicolas Is. In addition, data on the growth of Western Gull and Xantus' Murrelet chicks were obtained by the undergraduate independent study group on Santa Barbara Is.

Table III-133 presents the results of growth rate measurements for Western Gull chicks in 1975. The results for Santa Barbara Is. and

Table III-133. Western Gull chick growth rates, 1975.

Island	N	Mean growth rate in g/day	S.D.	Range
Prince Is.	3	18.2	2.1	15.9 - 19.8
San Nicolas Is.	11	31.5	10.0	16.8 - 47.5
Santa Barbara Is.	14	29.0	4.8	20.5 - 38.1

Table III-134. Summary of reproductive success of Western gulls on Santa Barbara Island, 1975. Data from the University of California, Irvine, independent study team.

	Clutch of one egg	Clutch of two eggs	Clutch of three eggs	Clutch of four eggs	Clutch of five eggs	Total
No. of nests	1	3	16	2	1	23
No. of eggs	1	6	48	8	5	68
% hatching	0	33%	63%	0	0	32%
% surviving to 500 g	-	100%	89%*	-	-	26%*

* Three chicks unaccounted for.

San Nicolas Is. are very similar overall, although at least two chicks on San Nicolas Is. had unusually high growth rates of 46 and 47 g per day. The growth rates on Santa Barbara Is. were similar to those found for gull chicks there in 1972 (Hunt and Hunt 1975). The lower growth rate of chicks on Prince Is. was almost certainly a result of the time at which our data were obtained and the very small sample size. The two visits to San Miguel were relatively late in the nesting season and required the measurement of chick growth between about 300 g and 750 g. Older chicks grow more slowly, and late in the season, growth rates of chicks may be low (Hunt and Hunt 1976a).

Xantus' Murrelet chicks gained no weight during the 1-3 days between hatching and leaving Santa Barbara Is. Weighings of chicks every two hours throughout the night also revealed no weight gain. On the basis of these data and observations made at night (Z. Eppley and D. Schwartz, pers. comm.), it is reasonable to assume that adult Xantus' Murrelets do not feed their young prior to the departure of the downy chicks to sea on the second night after hatching. Interestingly, no appreciable weight loss was recorded between hatching and departure from the nest.

3. Reproductive success

Due to the low frequency of our visits to the various islands, we were unable to obtain much useful data on reproductive success in 1975. However, the undergraduate independent study group on Santa Barbara Is. was able to obtain data on reproductive success of Western Gulls and Xantus' Murrelets.

Western Gull hatching success was fair in clutches of 3 eggs

and nil in supernormal clutches (Table III-134). However, once hatched, survival of chicks was very high (approximately 91%). This pattern of moderate hatching success and high chick survival is typical for Western Gulls on this island (Hunt and Hunt 1973, 1975).

Xantus' Murrelets also had only fair hatching success, but good chick survival (Table III-135). Desertion by parents, damage by rocks and, surprisingly, predation by mice (13 eggs) were the causes of egg loss. Owls, cats and gulls were all potential predators on chicks, but none of the chicks from the nests under observation were known to have been taken by these predators prior to their leaving the nest on the night of the second day after hatching. One murrelet chick was found regurgitated in the gull colony and was presumed to have been the victim of gull predation.

The BLM team mapped 148 Brandt's Cormorant nests on Prince Is. on 13 May, but these could not be checked again until 15 July, at which time most were empty. On San Nicolas Is., 52 active nests were counted on 20 April, but by 11 June all but 18 of these had been abandoned. Of these 18, 15 had chicks and 3 were empty on 19 June.

D. Discussion

The Channel Islands of California provide nesting sites for seabirds from February, when the earliest Brown Pelican nests may contain eggs, until late August, when the young of late nesting Ashy Storm-Petrels and Brandt's Cormorants may be expected to leave (Fig. III-224. During this nesting period, the adults are bound to their island nest sites and surrounding waters by the need to incubate eggs and to bring food to land-bound young (except in the case of the

Table III-135. Summary of reproductive success of Xantus' Murrelets, Santa Barbara Island, 1975.

No. of nests	No. of eggs	Mean clutch size	% of eggs hatching	% of chicks leaving nest
28	54	1.9	54	100%

Figure III-224. Range of egg dates for seabirds breeding in the California Channel Islands. Data from museum egg records and 1975 breeding season.

	Egg dates	
Ashy Storm-Petrel	13 May	27 July
Brown Pelican	24 Feb.	2 July
Double-crested Cormorant	3 May	2 July
Brandt's Cormorant	27 March	12 July
Pelagic Cormorant	insufficient data	
Western Gull	28 April	2 July
Pigeon Guillemot	14 May	10 July
Xantus' Murrelet	19 April	5 July
Cassin's Auklet	20 March	15 June

Xantus' Murrelet, in which downy young are taken to sea no more than two days after hatching). The timing of clutch initiation varies considerably between species and most likely will be found to vary between years.

At present, we have insufficient data to know the degree of synchrony in clutch initiation between colonies of most species in a given year. In 1975, on the basis of chick weights gathered, Western Gulls on most of the Channel Islands were at similar stages of the reproductive cycles at the same time. An exception was the colony on Santa Barbara Is. where clutch initiation was approximately 7-10 days behind that on the other islands and was also later and more drawn out than it had been in 1973 (see Fig. III-221 and Fig. III-222). This delay may have been due to the presence of an immature Peregrine Falcon (_Falco peregrinus_) which harassed the gulls during the courtship and nest-building stages of reproduction. It left Santa Barbara Is. on or about 6 May 1975.

Clutch size would not be expected to have changed in historical times for those species with either a one- or two-egg clutch. For species with larger clutches (cormorants and Western Gulls), a change in clutch size would only be expected if the age structure of the breeding population had changed. In the face of low reproductive output by cormorants, it is possible that fewer birds are breeding and that clutch size has increased since former times. However, given the historical data base, it is unlikely that an increase in the frequency of large clutches in cormorants could be detected, since egg collectors, upon whose work we depend for the older records, would

have passed up small clutches as "incomplete".

Changes in clutch size distribution can be documented for the Western Gull. Prior to 1968 only 2 clutches of 4 eggs were collected. However, since 1968 between 2% (Prince Is.) and 14% (Santa Barbara Is.) of Western Gull clutches have contained more than three eggs. On Santa Barbara Is. it has been shown that the supernormal clutches are the result of female-female pairs with both birds laying eggs in the same nest (Hunt and Hunt ms; Hunt, Hunt and Risebrough ms). At present we do not know why these pairs form, although it would be important to determine if there is any connection between the aberrant pairing and environmental contamination.

The reproductive success of Western Gulls on Santa Barbara Is. reflects the existence of this female-female pairing. Hatching success was within the low range of what might be considered a normal distribution for clutches of three or fewer eggs, while the eggs of the female-female pairs were infertile and failed to show development. Chick survival was high.

Xantus' Murrelets produced 1.1 chicks per nest. Without a life table for the species it is impossible to know how this rate of productivity related to the numbers of chicks required to maintain the population. However, while it is clear that murrelets suffer heavy egg loss prior to hatching, it is likely that chick mortality at sea is as great or greater. It will be exceedingly difficult to obtain data on mortality rates of chicks at sea.

Although we were unable to obtain good data on reproductive success of cormorants in most colonies, our data for San Nicolas Is. show an alarmingly low productivity of only 15 nests with chicks

out of 148 nests started.

E. Summary

We have provided data based on historical information and the 1975 study as to the timing of breeding and clutch size of the species of marine birds breeding in the Channel Islands of California. Although hampered by bad weather and boat trouble, we were able to document the presence of supernormal clutches in the nests of Western Gulls on several islands and the very low reproductive output of Brandt's Cormorants on San Nicolas Is. We were also able to obtain the first recorded data on the reproductive success of Xantus' Murrelets, as well as evidence that young murrelets are not fed by their parents prior to leaving their nests at or before age 2 days. Finally, data on the growth rates of Western Gull chicks on Santa Barbara, San Nicolas and Prince Islands were found to be within normal ranges.

SECTION IV

SEABIRDS

Chapter III

Foods and Foraging Ranges of Nesting Seabirds

G. L. Hunt, Jr., M. L. Quammen, and K. T. Briggs

III. BIRDS: Foods and Foraging Ranges of Nesting Seabirds

A. Introduction

In order to anticipate the potential impact of an oil spill on nesting seabirds, it is necessary to know where they go to forage and the kinds of foods upon which they are dependent. Nesting birds are restricted in the distance they travel seeking food by their need to return periodically to their nest sites for courtship, incubation, or feeding of chicks. Furthermore, during the nesting season food requirements are at a maximum, as the adults have to fulfill not only their own needs, but also obtain energy for egg production and for feeding growing young. The result is that nesting birds may be less flexible as to where they can seek food than are migrating or wintering birds which may be able to avoid a contaminated area by temporarily shifting to a new location.

Within the radius of the permissible foraging range, nesting seabirds may seek food in restricted, localized areas, either because these areas support particularly rich supplies of food, or because of the localized distribution of a particular prey item upon which the species may specialize. Thus, Bédard (1969, 1976), Sealy (1973) and Scott (1973), believe that alcids concentrate their foraging in "hot-spots" characterized by concentrations of food organisms. These concentrations may be in areas of upwelling, convergence, mixing or other oceanographic features. If this thesis is correct, then

the foraging efforts of alcids would be highly concentrated, and an oil spill in the vicinity of one of these prime areas would have a devastating effect on local populations (e.g. puffins in Brittany -- after the "Torrey Canyon" spill, Milon and Bougerol 1967; see also Clark, Joensen and others for discussion of the relationship between spatial distribution and vulnerability to oil spills).

In contrast, Cody (1973) believes that alcids forage in zones around their colonies. In his scheme, these zones are defined by the energetic requirements of the birds, their ability to carry food to their young and competition with co-existing species. To the extent that Cody may be correct, seabirds should be broadly dispersed around their nesting colonies, and the vulnerability of their populations to total destruction by an oil spill should be reduced.

Knowledge of the foods used by marine birds may not only help us to learn where they forage, but should also give us direct information about the food chains upon which they are dependent. The results of current and future studies on pollutant toxicity should prove useful in predicting the effects of various kinds of contamination on seabirds and on other organisms at higher levels of the food chain. This information may be important not only in predicting potential dangers to seabirds and in establishing baseline of present levels of contamination, but also because seabirds may serve as environmental indicators or as models of direct relevance to man. Seabirds are dependent in many cases on the same food chains as we are. Knowledge of seabird foraging habits and monitoring pollution

levels in marine birds may provide us with advance warning of contamination threats to man.

Relatively little is known about the feeding habits of marine birds nesting in the Southern California Bight. The only investigations of seabird foods conducted within the study area include Schreiber (1970) and Hunt and Hunt (1976b) on Western Gulls and Hubbs et al. (1970) on Brandt's Cormorants. Harper (1971), who studied Western Gull reproductive biology on Bird Rock at Santa Catalina Is., provided no data on foods or foraging behavior.

Studies on nesting seabirds in other localities in southern California provide useful comparative material. Ainley et al. (1974) give some information on the foods used by storm-petrels, and Ainley and Lewis (1974) include data on the foods of cormorants, as does the work of Wright (1913) and Bent (1922).

Data on the foods and foraging habits of southern California alcids are particularly scarce. Bent (1919) makes mention of all species, and Manuwal (1974a) and Thoresen (1964) provide data on Cassin's Auklets. While Drent (1965) gives an excellent account of Pigeon Guillemot foods in British Columbia, and Follett and Ainley (1976) provide data from the Farallon Islands, there are no studies of this species in southern California. Useful data on the foods of the Xantus' Murrelet are totally lacking.

The purpose of this study was to obtain data on the foods and foraging areas used by each of the species nesting on the Channel Islands. While it would be ideal to have detailed maps of the foraging ranges of all species on each islands, limits on time and funds precluded in-depth study on such a broad scale. Therefore we have concentrated our

efforts on those species about which the least was known concerning foraging ranges in southern California and have directed our most intensive effort toward those islands (Santa Barbara and San Miguel) which harbored the largest numbers of vulnerable alcids.

A banding program was initiated in order to trace movements of birds nesting in the Channel Islands and to provide information on normal mortality rates. The information on movements may allow us to determine if individuals shift from one colony to another during their lifespan and also to determine their distribution outside the breeding season. Data on mortality rates are essential for the construction of life tables which will allow an estimation of the ability of a population to recover from a catastrophe. Bands placed on young chicks were also used to identify individuals for determinations of growth rates and pre-fledging survival.

This paper includes results of work completed up to 31 December 1975. Data gathered during colony surveys in January, February and March 1976 will be included in the 1976 contract report.

B. Methods

In order to learn more about the foraging distribution and foods taken by nesting marine birds we used several different techniques. To collect foods, we obtained samples from nestlings either when birds voluntarily regurgitated during handling for banding or weighing (cormorants and some gulls) or by inserting an index finger down their throats and withdrawing the contents of the proventriculus (e.g., Western Gull, Hunt 1972). Samples thus obtained were placed in 5% buffered formalin and then transferred to 70% ethyl alcohol.

Transfer to ethyl alcohol was necessary so that the decalcifying action of the formalin would not damage invertebrates or fish bones and otoliths.

Three complementary methods were used to assess the foraging grounds of seabirds breeding on the Channel Islands: radial transects out from the islands by ship, color-marking of nesting birds, and radio telemetry. The three methods were needed because of the different problems posed by the various species and islands where they nested. Radial transects were particularly useful for murrelets, guillemots and cormorants which, for a variety of reasons, were either hard to capture, hard to color-mark or were so distributed at sea as to make survey by boat profitable. Color-marking was employed with gulls and Xantus' Murrelets, both of which are relatively easy to mark. Fimally, radio telemetry provided the possibility of tracing the daily movement patterns and the means to follow birds over long distances in areas where there were too few people available to provide sightings of color-marked gulls and murrelets.

1. Radial ship transects

Radial ship transects were conducted by running straight-line courses out as far as 46.25 km (25 NM) from Santa Barbara, San Nicolas and San Miguel Islands (Table III-136) at constant ship speeds. Birds within 400 m of either side of the boat were recorded and the time of their sighting noted. The data were then expressed as the number of individuals (by species) per one nautical mile (1.85 km) interval.

2. Color-marking

A second method of tracing movements of nesting birds was to dye them a color coded to a particular island. Western Gulls and

Table III-136. Radial ship transects through August, 1975.

A. San Miguel Island

Cruise No.	Date	Course (True)	Length in km (NM)
203	5/13/75	020° (out)	14.8 (8.0)
203	5/13/75	200° (in)	14.8 (8.0)
203	5/13/75	309° (in)	14.8 (8.0)
203	5/13/75	180° (out)	14.8 (8.0)
207	7/15/75	015° (out)	18.5 (10.0)

B. San Nicolas Island

Cruise No.	Date	Course (True)	Length in km (NM)
201	4/20/75	230° (in)	46.25 (25.0)
207	7/17/75	069° (out)	46.25 (25.0)

C. Santa Barbara Island

Cruise No.	Date	Course (True)	Length in km (NM)
201	4/19/75	115° (in)	46.25 (25.0)
201	4/20/75	230° (out)	46.25 (25.0)
201	4/21/75	055° (out)	18.5 (10.0)
201	4/21/75	235° (in)	18.5 (10.0)
201	4/21/75	173° (out)	14.8 (8.0)
201	4/21/75	350° (in)	14.8 (8.0)
201	4/21/75	067° (out)	46.25 (25.0)
202	5/09/75	013° (out)	7.4 (4.0)
202	5/10/75	232° (out)	6.5 (3.5)
202	5/10/75	080° (out)	37.0 (20.0)
204	5/27/75	295° (out)	46.25 (25.0)
207	7/16/75	115° (in)	46.25 (25.0)
208	7/23/75	014° (out)	7.4 (4.0)
208	7/23/75	134° (out)	7.4 (4.0)

Xantus' Murrelets on Santa Barbara Is. were dyed pink/red using Rhodamine Red and Western Gulls on Prince Is. were first dyed yellow with picric acid, and when the picric acid marks proved insufficiently bright, they were re-dyed green with Victoria Green. Crystals of these dyes were sprinkled around the edges of nests containing eggs or very young chicks. The adult birds made contact with the dye when they returned to their nests to incubate eggs or brood young. Dye was applied directly to adult murrelets while they incubated. Cormorants were not color-marked due to the difficulty of visibly marking their dark plumage and because we did not wish to cause undue disturbance to a group of birds suffering a major population decline.

Sightings of color-marked birds were sought during all sea trips by bird project staff members and by requesting reports of sightings by the public. Information was solicited from the public by writing to 136 yacht clubs, marinas and sport fishing establishments (Fig. III-225).

3. Telemetry studies

a. Materials and components

We used high-VHF range telemetry beacons supplied by AVM Instrument Co., Champaign, Illinois. The beacons were of two types: a lightweight, single-stage model for murrelets and a heavier, two-stage unit for gulls. The smaller beacons used an RM-575 mercury cell for power; the larger packages drew power from a 1/2 AA-size lithium cell. We calculated that, with power drains typical of the equipment we employed, both types of package had a field life of about 100 days.

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DEPARTMENT OF POPULATION AND
ENVIRONMENTAL BIOLOGY
SCHOOL OF BIOLOGICAL SCIENCES

IRVINE, CALIFORNIA 92664

Figure III-225

Gentlemen:

We are engaged in a study of the seabirds of the California Bight as a part of a Bureau of Land Management Baseline Study related to the possible sale of off-shore oil leases. The purpose of our study is to determine the number and distribution of seabirds which either visit the waters of Southern California or nest in the Channel Islands.

As a part of this study we have marked several species of birds, including Western Gulls, with harmless dye markers identifying the islands where these birds nest. It is our hope that you and other persons who spend time on the water will report to us sightings of these birds so that we can learn where the birds nesting on each island seek their food. This information may aid in their protection.

If you observe a bird marked with yellow, red or green colors, please inform:

Dr. George L. Hunt, Jr.
Department of Population and
Environmental Biology
University of California
Irvine, California 92664

or call

(714) 833-6006

We would like to know the DATE, PLACE, SPECIES OF BIRD AND COLOR of all marked birds you see. Your help in this effort will be greatly appreciated.

Sincerely,

George L. Hunt, Jr.
Asst. Professor

GLH:new

Transmitting antennas were stainless steel, 0.043 to 0.060 cm in diameter and 30.6 cm in length. Harnesses were uncoated surgical gut, surgical gut enclosed in plastic "shrink-tube", or stainless steel wire in "shrink-tube". Each had a "weak-link" of dissolvable gut that allowed the package to fall off within six to eight weeks (based on laboratory trials). Beacon components were bound and protected in dental acrylic; total package weights (including antenna and harness) averaged 5.7 gm for murrelets and 21.2 gm for gulls.

We used 24-channel receivers (LA-12, AVM Instrument Co.) and dual, four-element yagi antennae (Cush Craft) with null-peak attachments. These directional receiving antennae were mounted on two-meter high masts that allowed full 360° rotation. A compass was affixed to each antenna mast after the method outlined by Hallberg, Janza and Trapp (1974).

b. Harnessing and tracking

Western Gulls were captured by placing an inconspicuous noose of fishing line around nests containing incubated eggs and pulling the noose taut around the birds' feet when they returned to incubate. Gulls were then measured, color-marked with dye and/or plastic leg bands and harnessed with a telemetry package. We observed and noted the behavior of all birds at the time of release and at all subsequent resightings.

Xantus' Murrelets were either captured by hand on the nest (two of four individuals) or mist-netted as they came onto Santa Barbara Is. at night. We were only certain of the breeding status of the birds captured on the nest. After harnessing, the incubating

birds were returned to their nests where they remained at least until we departed the area. Birds that we caught in mist-nets were released near their site of capture. One bird, observed after harnessing, flew without difficulty.

Four packages were shed by gulls on Santa Barbara Is. as a result of weak harnesses or biting through the harness material. We modified the harnesses on the remaining five Santa Barbara Is. gull packages and all Prince Is. units and detected no further self-removals. Additionally, two Santa Barbara Is. gulls deserted their nests one or two days after their capture and harnessing. To our knowledge, no nest desertions occurred among the harnessed Prince Is. gulls.

We monitored the activities of telemetry subjects from two receiving positions on each island. Receiving positions were selected to maximize elevation and triangulation base and minimize the amount of nearby gradients in surface topography. The triangulation base at Santa Barbara Is. was 1.2 km (0.65 NM) and 3.9 km (2.1 NM) at San Miguel Is.

Observers attempted to locate each telemetry subject, allowing approximately five minutes for search and localization of each beacon. Communication between observers was maintained by use of walkie-talkies. Each position record included relative strength of the signal, location of nulls and peaks, and for 103 of the fixes on San Miguel Is., comments on the breadth of the primary signal null. The last notation provided the basis for estimating the potential error in fixes.

Potential error in plotting transmitter location was dependent on distance and position of the transmitter relative to the receivers and the length of the triangulation base. The potential for both lateral and distance errors in plotting transmitter positions increased with distance between a beacon and the triangulation base and when the triangulation base was short (Santa Barbara Is.). Potential distance errors also increased as the direction from the colony to a beacon approached the orientation of the triangulation base (Figs. III-226 and III-227, Table III-137). (Error polygons are not plotted in Figs. III-232 through III-239. The reader is referred to the preceding discussion and Table III-137 for estimates of precision under differing circumstances.)

4. Banding

Standard U.S. Fish and Wildlife Service aluminum bands were used throughout the bird studies. In addition, adult Western Gulls on Santa Barbara Is. were color banded to code for reproductive information. Adult murrelets and auklets were captured in their burrows or nest crevices, and adult Western Gulls were captured by snaring with a hand-held monofilament loop placed around the nest. Young were hand-caught in their nests or where they hid in the vegetation.

C. Results

1. Foods

We obtained a total of 91 samples from two species (Table III-138) on five islands. Ashy Storm-Petrels, Cassin's Auklets and Xantus' Murrelets were handled but none regurgitated food and these species were too small for the "finger" technique. Of the 12 Brandt's

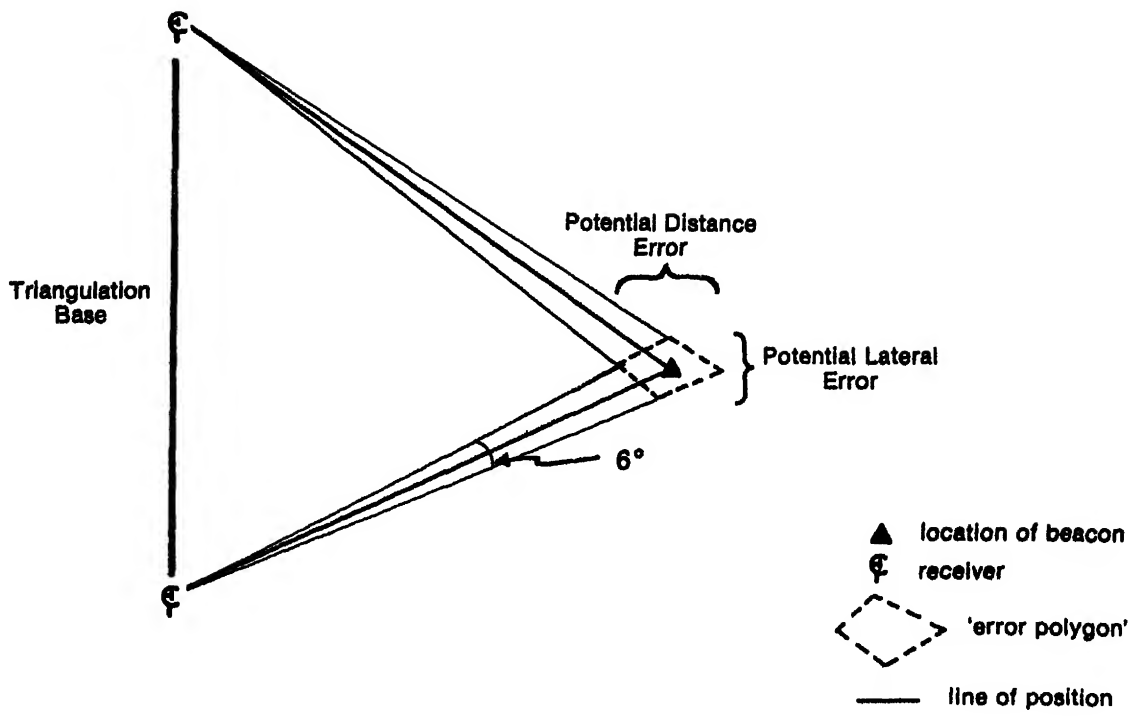


Figure III-226. Schematic of the method used to plot positions of telemetry subjects and limits of potential errors. The intersection of lines of position from each of two receiving stations determines beacon location. An "error polygon," that area enclosing potential distance and lateral errors in plotting beacon position, is drawn by projecting lines 3 on either side of lines of position (corresponding to 6' average breadth of primary signal null)

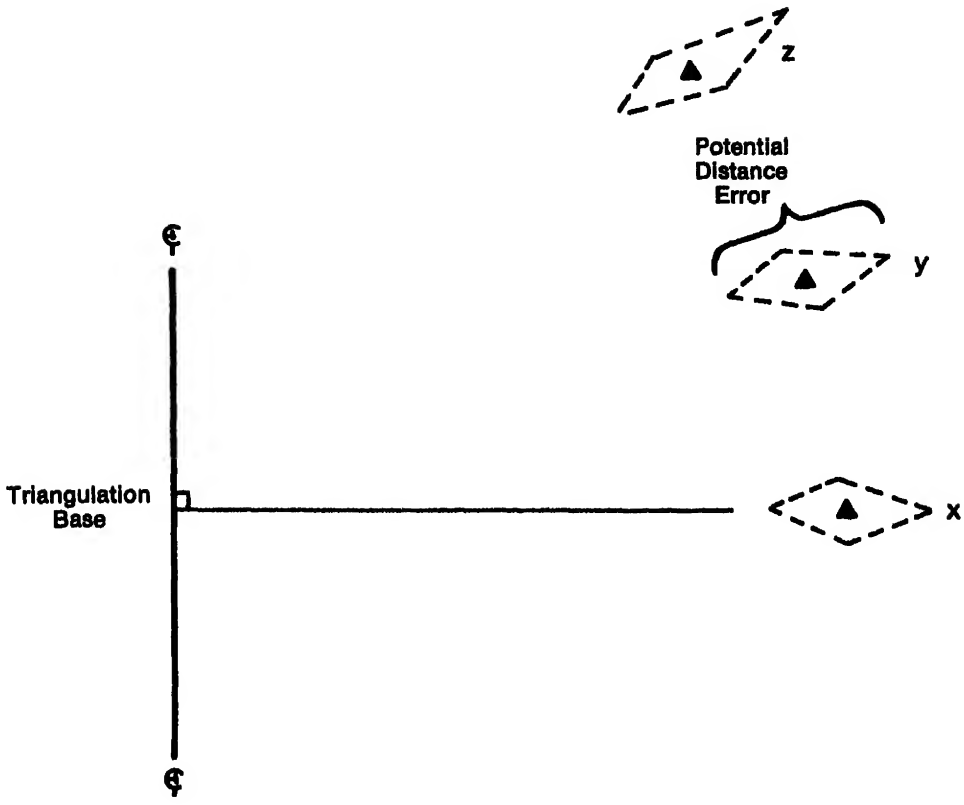


Figure III-227. Effect of beacon position on the dimensions and shape of "error polygons" (beacon positions X, Y, Z are equidistant from the center of the triangulation base). Potential distance error is minimal when a beacon is at a high angle relative to the triangulation base (position X) Increase in distance from receivers or decrease in triangulation base increases potential errors See preceding Figure for explanation of symbols.

Table III-137. Approximate dimension of "error polygons" in plots of beacon positions as a function of distance and triangulation base. Figures indicate potential errors for fixes at a high angle (perpendicular) relative to the triangulation base. Potential distance error is greater on low-angle fixes. Dash indicates that no fixes corresponding to the given distance were encountered in the field.

	San Miguel Island Triangulation base = 3.9 km		Santa Barbara Island Triangulation base = 1.2 km	
Distance between beacon & triangulation base	Potential distance error (±)	Potential lateral error (±)	Potential distance error (±)	Potential lateral error (±)
0-5 km	1.0 km	0.5 km	1.0 km	0.5 km
5-10 km	1.0	0.8	12	0.9
10-15 km	7.5	1.0	27	1.5
15-20 km	15	1.5	39	2.8
20-25 km	39	2.5	100	2.5
25-30 km	92	2.8	see note a.	
30-35 km	100	3.0	see note a.	
35-40 km	--	--	see note a.	

a. Lines comprising estimate of distance error diverge when beacon is beyond 25 km.

Table III-138. Distribution of food samples obtained in the Channel Islands during 1975.

Species	Anacapa Is.		Prince Is.		San Nicolas Is.		Santa Barbara Is.		Santa Catalina Is. Bird Rk.		Total Samples
	Birds	Samples	Birds	Samples	Birds	Samples	Birds	Samples	Birds	Samples	
Brandt's Cormorant chicks			6	3	6	2					5
Western Gull adult				1				7			8
Western Gull chicks	35	9	121	26	90	21	57	18	18	4	78
TOTAL SAMPLES		9		30		23		25		4	91
Number of visits to island	2		2		2		2		1		

Cormorant chicks handled, 42% yielded food samples, while 24% of 321 Western Gull chicks yielded samples. Eight samples were obtained from adult gulls.

Foods obtained from three Brandt's Cormorant chicks on Prince Is. and from two on San Nicolas Is. on June 18 and 19 respectively, are listed in Table III-139. All samples contained fish, only two of which were identified as Scorpaenidae sp. The advanced stage of digestion of the fish in the samples precluded a more accurate identification.

Table III-140 lists foods from seven adult Western Gulls sampled on Santa Barbara Is. between 7 and 25 May 1975 and from one adult Western Gull sampled on Prince Is., 30 May 1975. The samples from Santa Barbara Is. are considered together as they all repesent foods taken from incubating adults. It is clear from these results that fish and the squid, Loligo opalescens, make up the major portion of the diets of the adult birds sampled.

Foods fed to young Western Gulls showed considerable diversity, both within and between islands (Table III-141). As was the case with the incubating adults, fish and squid predominated in the samples from all islands. Particularly noteworthy is the heavy utilization of squid by birds on Prince Is. This contrasts with the marked preponderance of fish taken on the other islands, especially northern anchovy (Engraulis mordax) on Santa Barbara Is. It is also significant that food originating from man was observed only on Anacapa Is. The variation in foods used by the birds on the different islands (summarized in Table III-142) will make it very difficult to generalize about differences or similarities in food preferences or food availability between islands.

Table III-139. Foods of Brandt's Cormorant chicks, 1975.

Island	Number handled	Number samples	Percent empty	Food used	Number samples	Total weight (g)	Percent occurrence	Percent weight
Prince Is.	6	3	50	Scorpaenidae sp.	3	164	100	
				fish sp.	2			
San Nicolas	6	2	66	Scorpaenidae, sp.	1	14	50	25
				fish, sp. 1	1	24	50	42
				fish, sp. 2	1	10	50	18
				fish, sp. 3	1	8	50	14

Table III-140. Food used by Western Gull adults in May 1975.

SANTA BARBARA ISLAND - 7 birds

Food used	No. of samples	Total weight	Percent by occurrence	Percent by weight
Loligo opalescens	2	59	29	16
Natantia (shrimp)	2	17	29	5
euphausiid sp.	1	12	14	3
Trachurus symmetricus	2	99	29	27
fish sp.	3	147	42	40
passerine bird	1	38	14	10

PRINCE ISLAND - 1 bird

Food used	No. of samples	Total weight	Percent by occurrence	Percent by weight
Loligo opalescens	1	6	100	16
fish, sp.	1	32	100	84

Island	Number handled	Number samples	Percent empty	Food used	Number samples	Total weight (g)	Percent by occurrence	Percent by weight
Prince	121	26	78.5%	Loligo opalescens	6	371	38	58
				euphausiid sp.	2	5	7.7	0.8
				atherinid fish	1	70	3.8	10.7
				Sardinops caeruleus	1	12	3.8	1.9
				eel sp.	1	4	3.8	0.6
				fish sp.	12	104	46	16
				sea lion placenta	1	22	3.8	3
				? striated muscle	2	51	7	8
Anacapa	35	8	76	atherinid fish	2	78	25	40
				fish sp.	4	66	50	34
				chicken & bones	3	20	37.5	10
				lunchmeat	1	30	12.5	15
San Nicolas	91	21	77	Pollicipes polymerus	1	1	5	0.2
				gastropod, sp.	1	6	5	1
				Loligo opalescens	2	50	10	9
				euphausiid sp.	1	5	5	0.9
				Amphistichus argenteus	2	50	10	9
				Engraulis mordax	4	86	19	16
				Scorpaenidae, sp.	1	20	5	3.7
				fish sp.	10	248	48	46
				sea lion placenta	3	72	14	14
Santa Barbara	57	18	68	Pollicipes polymerus	2	2	11	1.6
				Loligo opalescens	0	0	0	0
				Octopoda, sp.	1	26	6	8
				Engraulis mordax	4	102	22	32
				Cololabis saira	1	12	6	3.8
				fish sp.	11	146	61	46
				sea lion placenta	1	12	6	4
				?	1	16	6	5
Bird Rk. (Santa Catalina)	18	4	78	fish sp.	3	68	75	85
				?	1	12	25	15

Table III-142. Percent by weight of foods found in Western Gull chicks during 1975.

Food	Anacapa Is.	Prince Is.	San Nicolas Is.	Santa Barbara Is.	Bird Rk.
fish, natural origin	74%	30%	75%	81%	
fish (?) origin					85%
Loligo opalescens		58%	9%		
octopus				8%	
euphausiid sp.		1%	1%		
sea lion placenta		3%	14%	4%	
garbage	26%				
(?)		8%		5%	15%
Pollicipes polymerus			0.2%	0.6%	
gastropod			1%		
TOTAL	100%	100%	100%	100%	100%

2. Radial transects

During the course of the spring of 1975, our concept of the use of ship time during islands surveys evolved from having the ship sit idle while we worked on an island through checking the at-sea distribution of one species (Xantus' Murrelet) to doing standardized transects to determine the distribution of all species in the vicinity of Anacapa, San Miguel and Santa Barbara islands. The 1975 data reported here were the results of a test of the feasibility and value of the radial transect method. A detailed analysis of bird distribution at sea around their breeding colonies will be presented at the end of the 1976 breeding season.

Tables III-143, 144 and 145 provide a summary of the distances offshore from their nesting islands at which the various breeding species were found. Brandt's Cormorants were generally concentrated close to the islands where they nested, although they regularly occurred up to 5.6-9.3 km (3 to 5 NM) at sea. In contrast, while the largest numbers of Western Gulls were found within 3.7 km (2 NM) of their colonies, their distribution was farily even from 3.7-18.5 km (2 to 10 NM) out. This suggests that, unlike cormorants which concentrated in the shallow inshore areas, gulls well dispersed at sea.

Among the alcids, three quite different patterns seem to exist. Pigeon Guillemots, as expected, were found close inshore and, except for one survey at Prince Is., were never seen more than 1.85 km (1 NM) from their nesting islands. Fourteen Pigeon Guillemots were seen within a single 1.85 km (1 NM) segment about 2 km southeast of

Table III-143 Summary, average number of sightings on radial transects - San Miguel Island, nesting species 1975.

Species[1]	Month	Distance away from island in km (NM)									
		0-1.85 (0-1)	1.85-3.70 (1-2)	3.70-5.55 (2-3)	5.55-7.40 (3-4)	7.40-9.25 (4-5)	9.25-11.1 (5-6)	11.1-12.95 (6-7)	12.95-14.8 (7-8)	14.8-16.65 (8-9)	16.65-18.5 (9-10)
COB	May	4.75	1	2 25	0.25	0.5	0	0	0	-[2]	-
COB	July	0	0	0	0	0	0	0	0	0	0
GUW	May	5	1	2.75	1.25	2.5	1.5	3	1.75	-	-
GUW	July	0	2	1	1	2	0	0	0	0	0
MLX	May	0	0.75	0	0.5	0	0	0.75	0	-	-
MLX	July	0	0	0	0	0	0	0	0	0	0
AKC	May	2.5	5	15	23.5	29.75	17.25	9.25	9.5	-	-
AKC	July	0	0	4	3	0	2	21	3	0	0
GP	May	1.75	0.75	0.25	3.5	0	0	0	0	-	-
GP	July	0	0	0	0	0	0	0	0	0	0

[1] COB, Brandt's Cormorant; GUW, Western Gull; MLX, Xantus' Murrelet; AKC, Cassin's Auklet; GP, Pigeon Guillemot.

[2] "-", no data taken.

Table III-144 Summary of sightings on radial transects - San Nicolas Island, nesting species 1975[1].

Species	Month	0-1.85 (0-1)	1.85-3.70 (1-2)	3.70-5.55 (2-3)	5.55-7.40 (3-4)	7.40-9.25 (4-5)	9.25-11.1 (5-6)	11.1-12.95 (6-7)	12.95-14.8 (7-8)	14.8-16.65 (8-9)	16.65-18.5 (9-10)
		Distance away from island in km (NM)									
MLX[3]	April	-[2]	0	0	4	2	0	6	0	0	4
MLX[3]	July	0	0	0	0	0	0	0	0	0	0
GUW	April	-	-	-	-	-	-	-	-	-	-
GUW	July	2	3	8	5	1	1	1	0	0	0

[1] one trip in April, 1 in July

[2] "-", no data taken

[3] breeding status uncertain

Table III-145 Summary, average number of sightings on radial transects - Santa Barbara Island nesting species 1975.

Species	Month	0-1.85 (0-1)	1.85-3.70 (1-2)	3.70-5.55 (2-3)	5.55-7.40 (3-4)	7.40-9.25 (4-5)	9.25-11.1 (5-6)	11.1-12.95 (6-7)	12.95-14.8 (7-8)	14.8-16.65 (8-9)	16.65-18.5 (9-10)
		Distance away from island in km (NM)									
COB	April	-[1]	-	-	-	-	-	-	-	-	-
COB	May	-	-	-	-	-	-	-	-	-	-
COB	July	7.0	0	1.5	0	0	0	0	0.5	0	0
GUW	April	-	-	-	-	-	-	-	-	-	-
GUW	May	11.4	0.67	1.0	0.25	0.67	0.67	0.5	0	2.0	0.5
SUW	July	5.2	2.5	1.0	0.67	2.0	1.0	0	1.0	0	0
MLX	April	0.33	13.0	10.5	1.5	0.7	1.1	1.4	0	0	0.7
MLX	May	2.0	2.6	2.25	1.5	2.0	6.5	1.0	5.0	10.0	10.0
MLX	July	0	0	0	0	0	0	0	0	0	0
GP	April	-	-	-	-	-	-	-	-	-	-
GP	May	6.0	0	0	0	0	0	0	0	0	0
GP	July	0	0	0	0	0	0	0	0	0	0

[1] "-", no data taken

Richardson Rk. (8 km off San Miguel Is., Table III-143). Although no birds were nesting on Richardson Rk. itself, it provides an inshore foraging habitat preferred by Pigeon Guillemots.

Cassin's Auklets, for which we obtained good data at San Miguel Is., appeared to be concentrated well offshore between 7.4 and 14.8 km (4-8 NM) out. The present data indicate that Cassin's Auklets concentrate their foraging to the north and west of San Miguel Is. over shallow waters and escarpments rather than in deeper water. Very few have been sighted to the east between San Miguel and Santa Rosa Islands or off the southern side of San Miguel Is. (Fig. III-228).

Xantus' Murrelets exhibited a third pattern. In April at Santa Barbara Is., sightings were concentrated in a band 1.85-5.55 km (1-3 NM) off the island (Fig. III-229). In late May, this concentration had dispersed, and most birds were seen at distances greater than 9.25 km (5 NM) from the island (Fig. III-230). In July, no murrelets were seen on one 18.5 km (10 NM) and two 7.4 km (4 NM) transects. Fig. III-231 shows the relationship of the number of murrelet sightings on a transect to the direction of that transect from Santa Barbara Is. It is clear that murrelets were less abundant to the south of the island.

Most murrelets were seen in pairs, and we suspect they are part of a large, non-breeding population which remains in the vicinity of the breeding colony. However, until we obtain specimens which can be checked for sex and breeding condition, the status of these birds will remain undetermined.

3. Color marking

On Santa Barbara Is., we placed red dye in 425 nests of Western

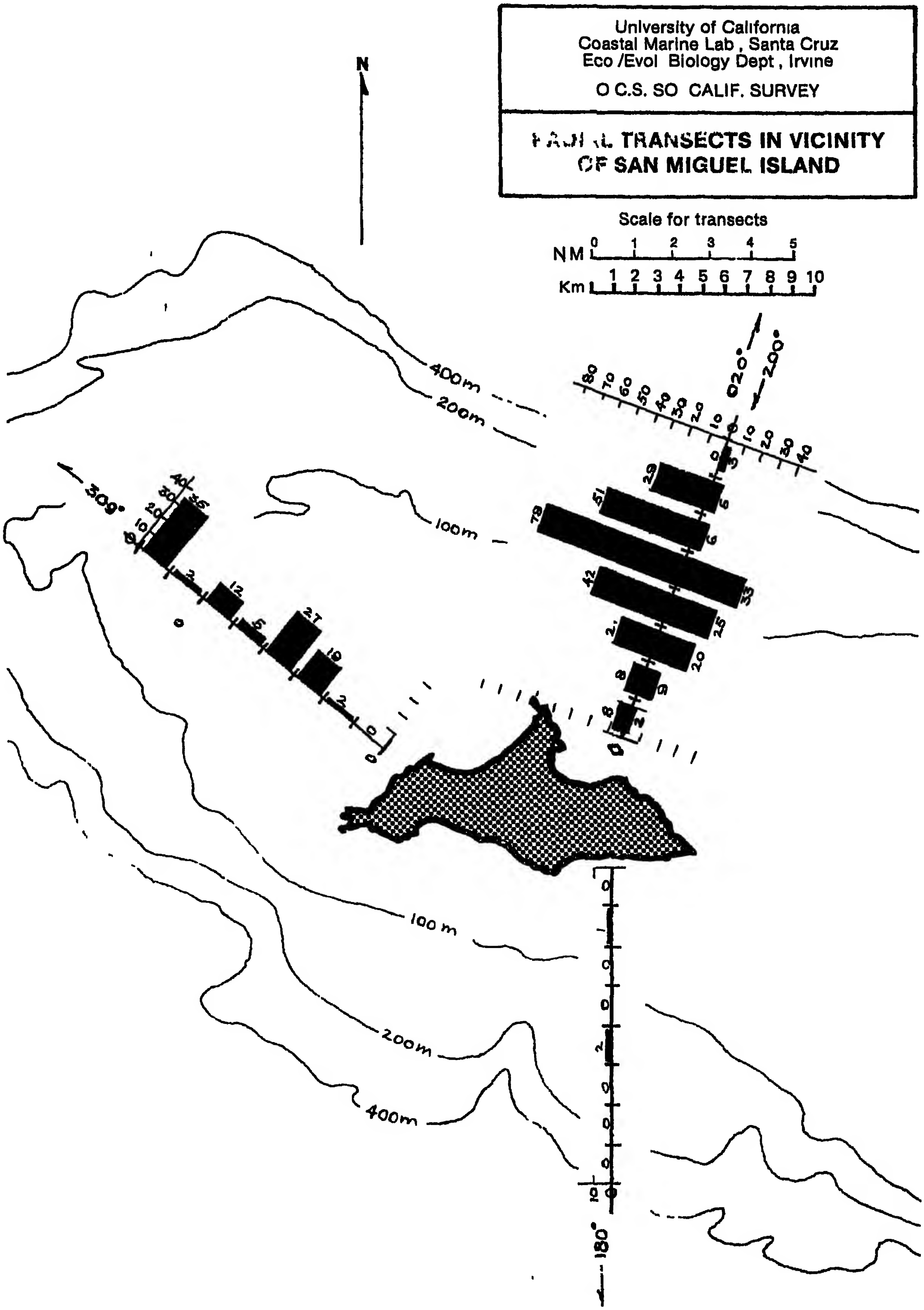


Figure III-228. Distribution of Cassin's Auklet at sea, May 1975. Numbers of birds sighted per 1.85 km (1 nm) on indicated headings.

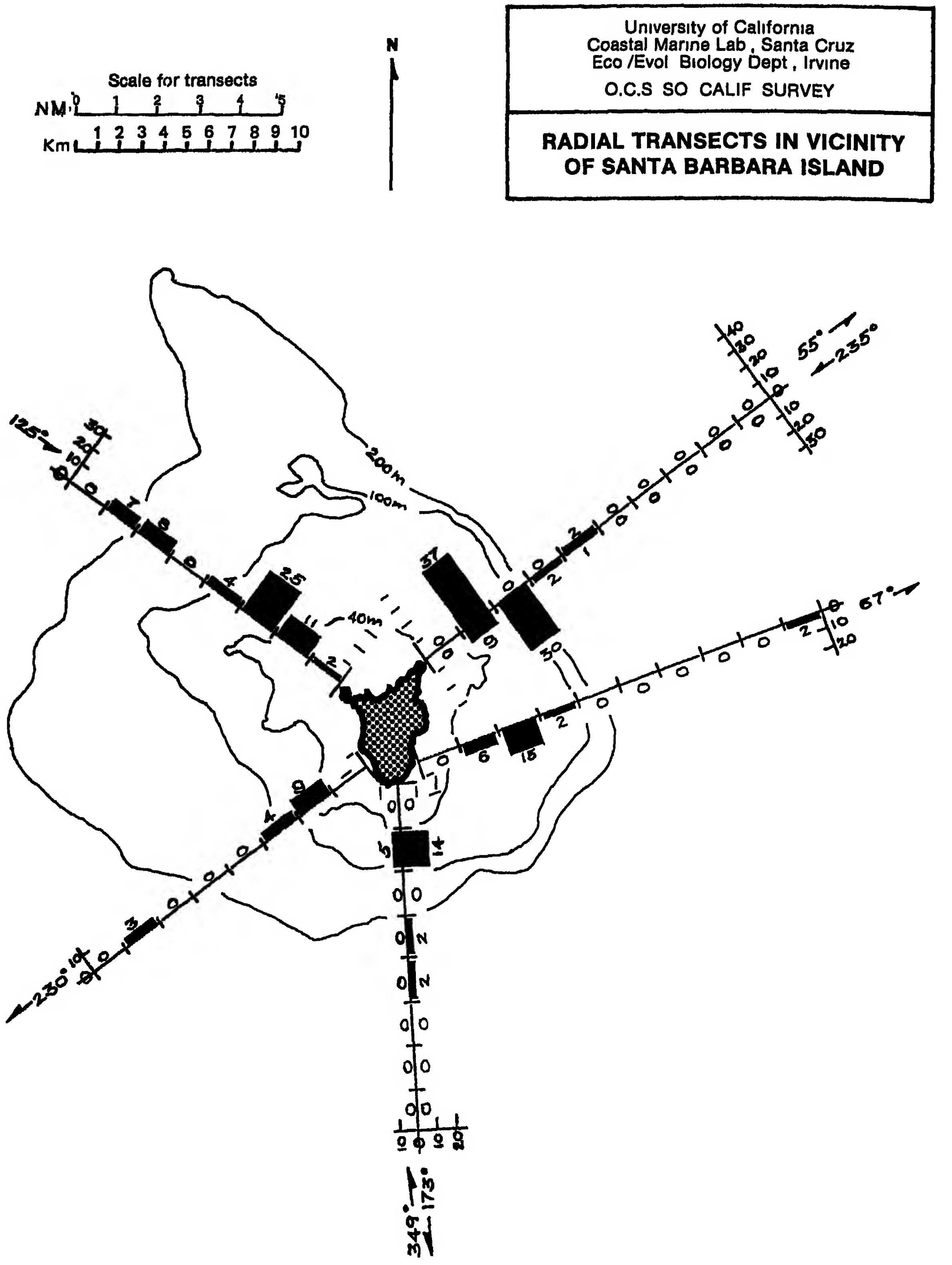


Figure III-229 Distribution of Xantus' Murrelet at sea, April 1975. Numbers of birds sighted per 1.85 km (1 nm) on indicated headings.

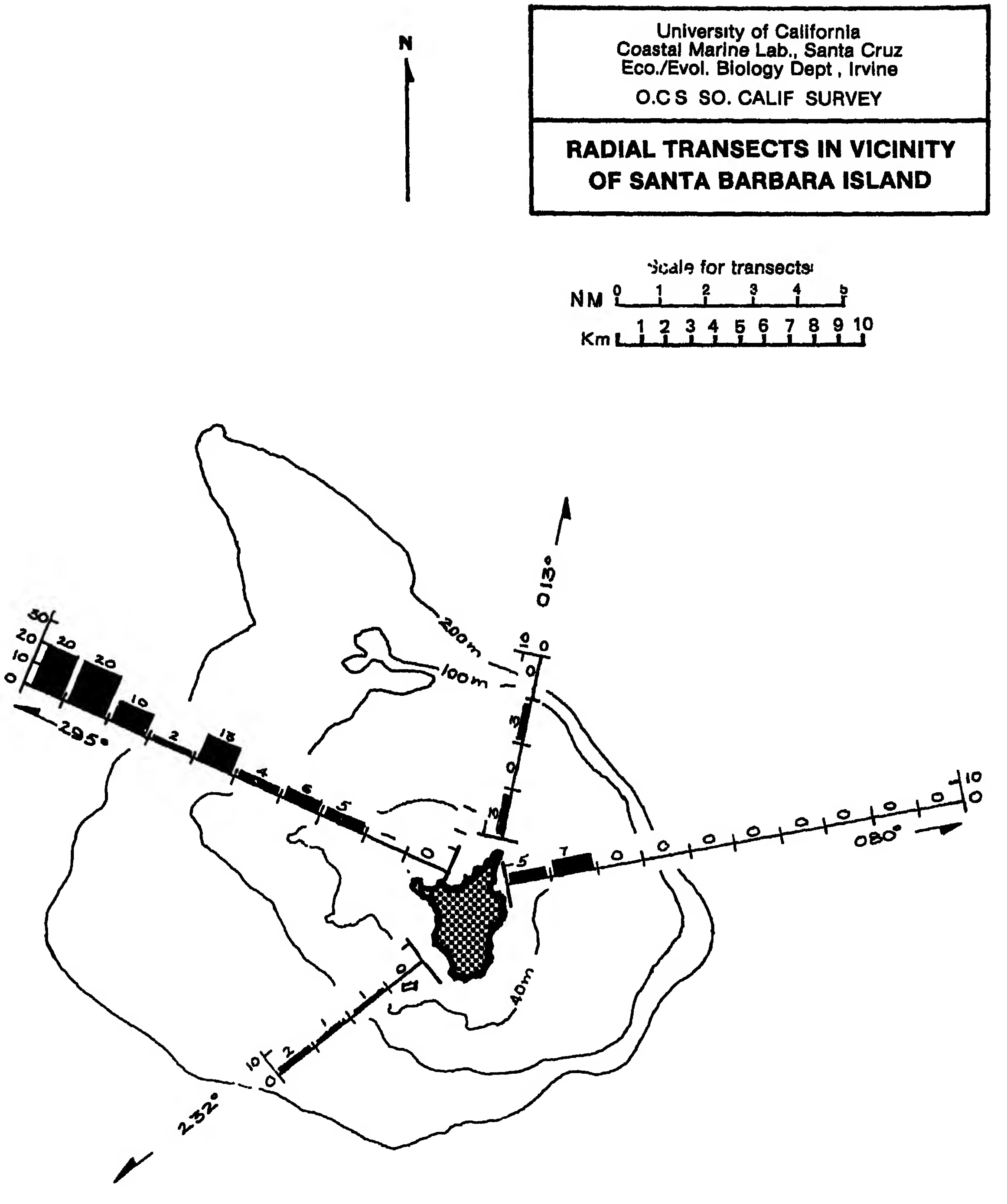


Figure III-230. Distribution of Xantus' Murrelet at sea, May 1975. Numbers of birds sighted per 1.85 km (1 nm) on indicated headings.

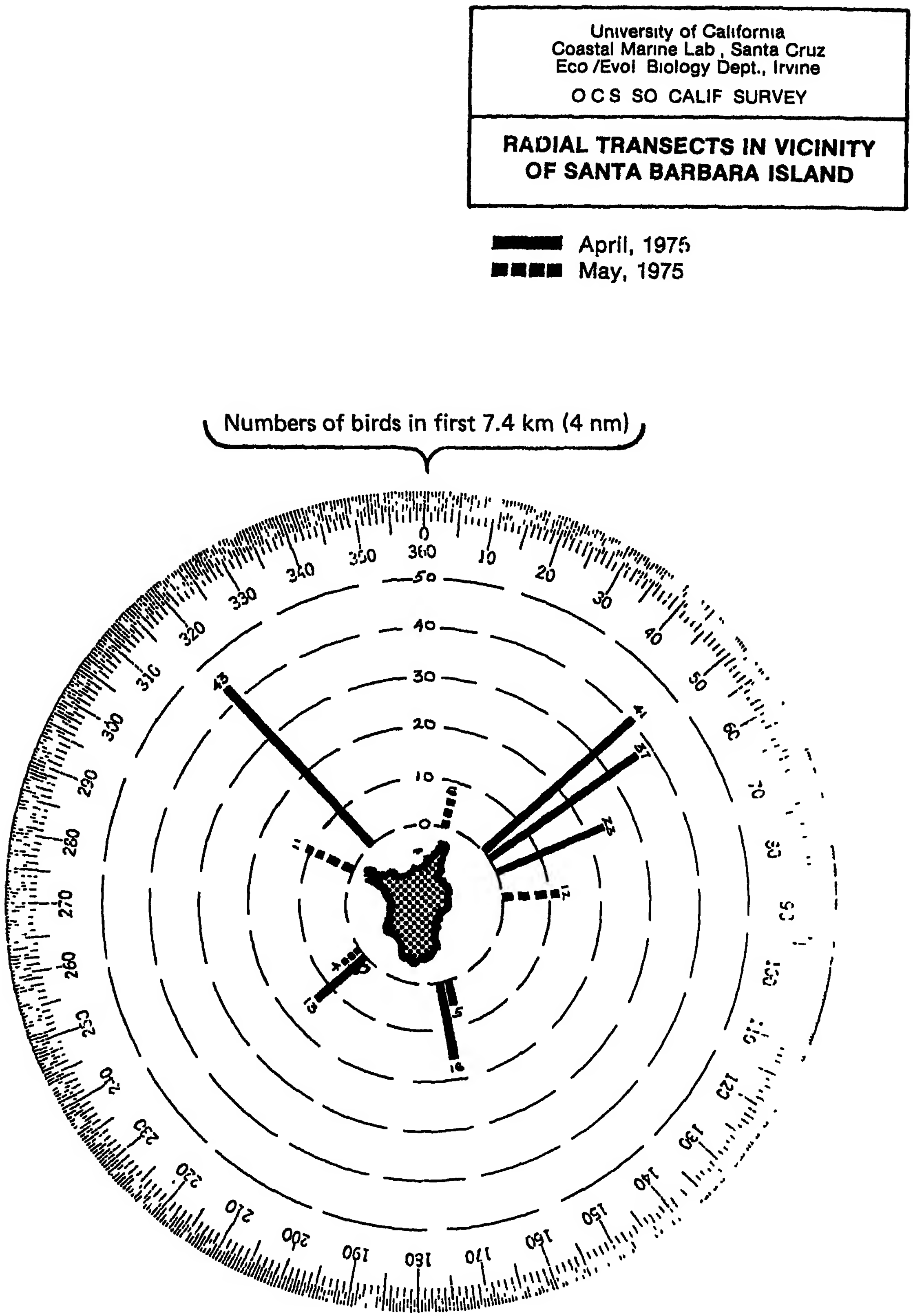


Figure III-231. Numbers of Xantus' Murrelet in first 7.4 km (4 nm) from shore on indicated headings, April vs. May, 1975.

Gulls and marked approximately 15 Xantus' Murrelets. On Prince Is. we placed green dye in about 115 Western Gull nests.

There were no sightings of color-marked Xantus' Murrelets, perhaps because the marks were too faint and difficult to spot on the small birds and because the sample size was small. There were 17 sightings of red-marked Western Gulls, comprising over 100 individuals, and two sightings of green-marked gulls. Of these 19 sightings, eight came from the public (Table III-146).

The sightings of Western Gulls marked red on Santa Barbara Is. were very instructive. While sighting distribution partly reflects the distribution of project boats, we did find these gulls commuting all the way to the mainland to feed during the incubation phase. As noted in our discussion of foods, no garbage or waste was found for Santa Barbara Is. gulls. Thus, the birds apparently forage over a wider area during relief from incubation than they do when feeding young.

It is also interesting to note that, despite numerous boat runs between San Nicolas Is. and Santa Barbara Is., there were no reports of pink gulls to the west of Santa Barbara Is. The sighting of a green-marked gull between Santa Barbara and Santa Rosa islands suggests that this area may be used for foraging by gulls from Prince Is.

4. Radio telemetry studies

We placed telemetry packages on seabirds at Santa Barbara Is. from 21 May to 24 May 1975, and at San Miguel Is. (Prince Is. colony) on 28 and 29 May. In all, 20 beacons were placed on Western Gulls (nine of these at Prince Is.), and four were placed on Xantus' Murrelets (all on Santa Barbara Is.). We made an attempt to capture cormorants

Table III-146. Summary of sightings of color-marked Western Gulls in the Southern California Bight, April - June, 1975.

Date	Color	No. of birds	Location	Sighted by
April, May, June	red	over 100	South Coast Botanic Gardens & adjacent landfall, Palos Verdes Penin.	public
spring	red	3 daily	22nd St. Landing, San Pedro	public
Apr-May	red	several	West of Santa Catalina Is.	public
15 May	red	several	Osborn Bank, south of Santa Barbara Is.	public
18 May	red	1	Redondo Pier	public
21 May	red	1	33°30'N, 118°56'W	project staf
21 May	red	1	33°30'N, 118°52'W	project staf
21 May	red	1	33°32'N, 118°45'W	project staf
21 May	red	1	10 miles off Pt. Vicente	project staf
27 May	red	1	33°34'N, 119°12'W	project staf
27 May	red	1	33°36'N, 119°18'W	project staf
27 May	red	1	33°33'N, 119°08'W	project staf
27 May	red	1	33°29'N, 118°58'W	project staf
30 May	red	1	12.5 miles east of Santa Barbara Is.	U.C. Irvine
1 June	red	1	Redlands Pier	public
19 June	red	1	Between Catalina Harbor and Little Harbor, south side of Santa Catalina Is.	public
13 July	red	1	0.9 km (1/2 NM) west of L.A. Harbor light	public
28 May	green	1-2	Between Santa Rosa Is. and Santa Barbara Is.	crew of the vessel "Pacific Clipper"
3 June	green	1	San Miguel Passage	project staf

at San Miguel Is. but desisted when it became apparent our activity would lead to nesting failure of any birds captured.

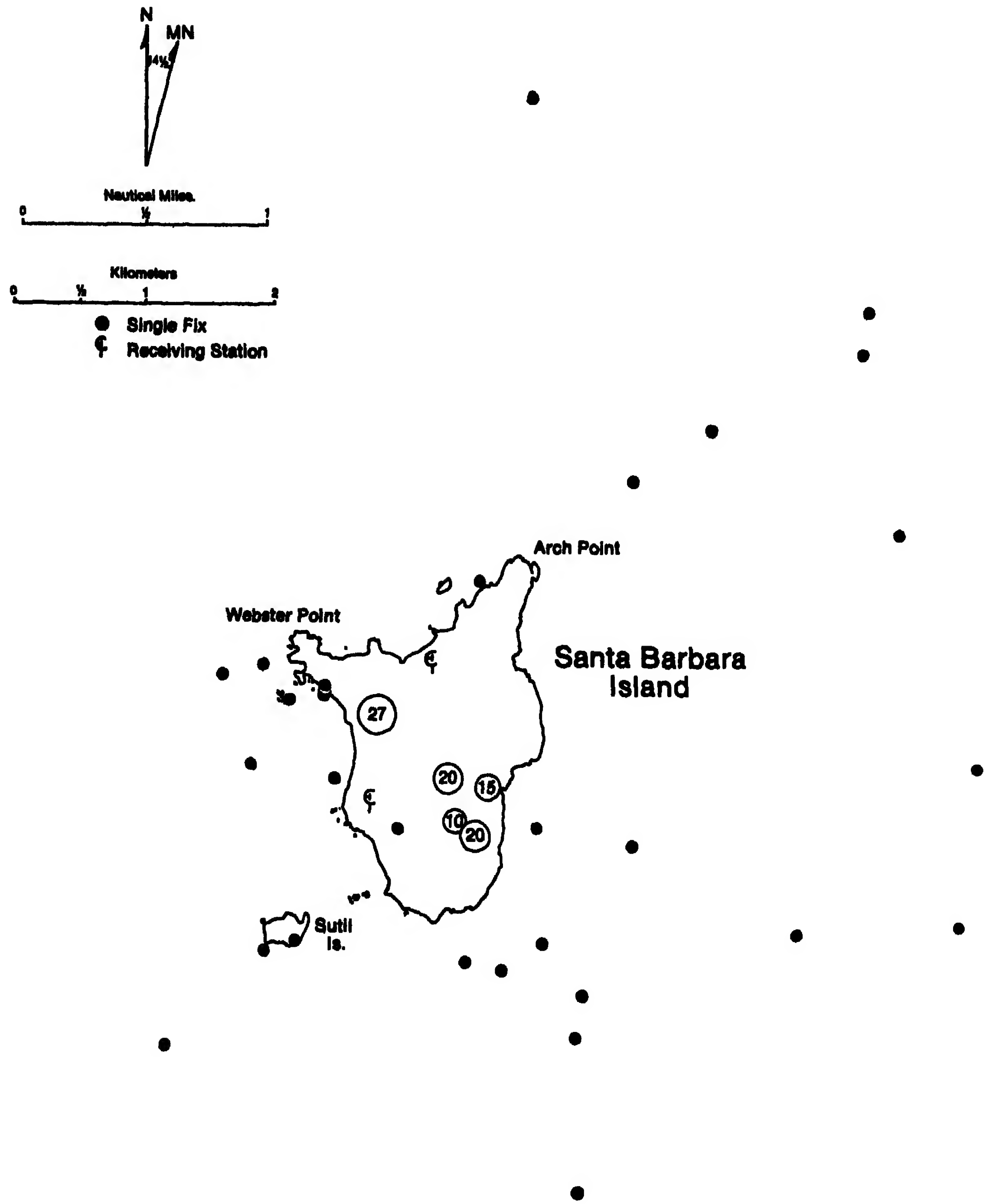
We tracked individual Western Gulls for a maximum of four and one-half days and Xantus' Murrelets for a maximum of three days. Different results were obtained at the two colonies, so they will be discussed separately.

a. Santa Barbara Island

Western Gulls: Our tracking data were collected from 21 to 26 May 1975; during this period fog and low haze were encountered between approximately 1700 each evening and 1200 the following day, with clearing in the afternoons. Winds were light and variable until late afternoon, becoming NW 10-30 km/hr in the evenings. Ninety-eight of 142 total fixes of gulls were either from the colonies themselves or from nearby roosting areas. This pattern is probably due in part to the preponderance of females among our subjects (based on mensural critera supplied by M.W. Hunt). Pierotti (1976) has demonstrated that female Western Gulls on Santa Barbara and the Farallon Islands spend considerably more time incubating than their mates which spend more time at sea. The remaining fixes (44), those that came from areas seaward of the island, were concentrated in nearshore waters. Nineteen fixes (43.2% of all off-island fixes) were less than 1.85 km (1 NM) out to sea. The remainder of the off-colony fixes decreased in frequency as distance from the colony increased; the most distant fix was approximately 38.9 km (21 NM) to the east of Santa Barbara Island.

Fig. III-232 shows that nearshore fixes were concentrated

Figure III-232. Distribution of 124 onshore and inshore fixes (up to 5 km at sea) of eleven adult Western Gulls tracked from Santa Barbara Island from 21 through 26 May 1975.



west of Webster Pt. (a kelp bed area often used for bathing and roosting) and beyond the kelp to the northeast and southeast of the island. Tracks of two individual birds on 24 May gave several consecutive fixes (covering several hours' time) within a few km southeast of the colony. Since these fixes were 45 to 65 minutes apart, these birds may have been foraging in the shallow waters just off the island.

More distant fixes came primarily from the areas between 330° and 120° T relative to Santa Barbara Is.; the majority of these (11 of 18 fixes farther than 4.6 km [2.5 NM] from land) were between 60° and 90° T (Fig. III-233). There were no distant gull fixes from the southeast, south , or southwest. Close approach to Santa Catalina Is. was recorded (two fixes, far to the east).

Xantus' Murrelet: In contrast to the results of gull tracking, Xantus' Murrelets were almost exclusively recorded at sea rather than on the breeding colonies. Less than 10% of the fixes were from land. Most murrelet fixes were close to the island (13 of 21 at-sea fixes, or 61.9%, were within 4.6 km [2.5 NM] of the island) while the greatest distances recorded were 9.8 and 11.5 km (5.3 and 6.2 NM) from land (Fig. III-234). These distances are probably the greatest possible with the lightweight, low-powered telemetry beacons in use, so we cannot exclude the possibility that Santa Barbara Is. murrelets may travel farther.

Individual fixes were spread out from approximately 340° to 130° T relative to Santa Barbara Is. with the great majority falling between 340° and 60°. As with the Western Gull tracks, telemetered murrelets seemed not to utilize areas south and southwest

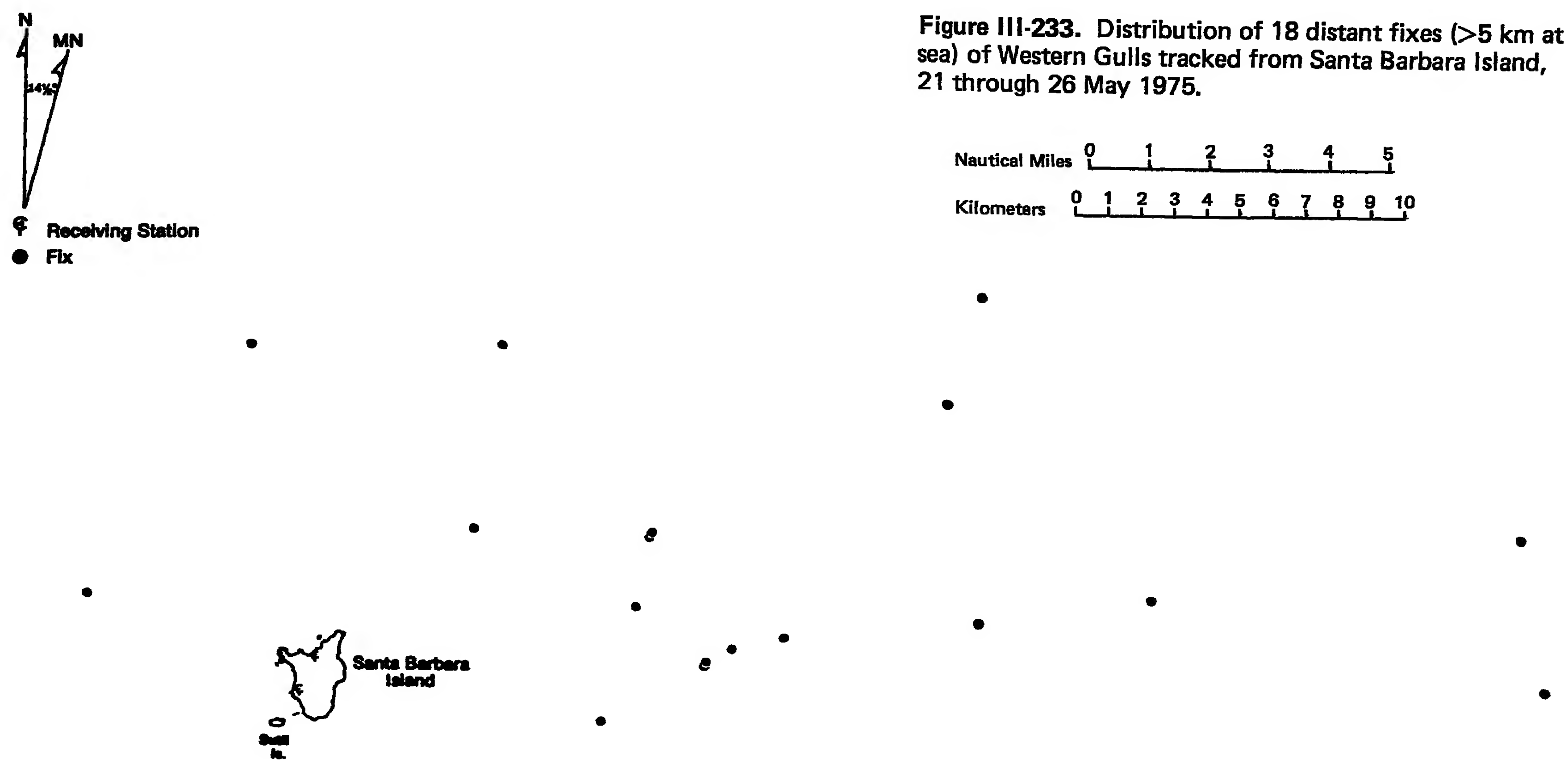


Figure III-233. Distribution of 18 distant fixes (>5 km at sea) of Western Gulls tracked from Santa Barbara Island, 21 through 26 May 1975.

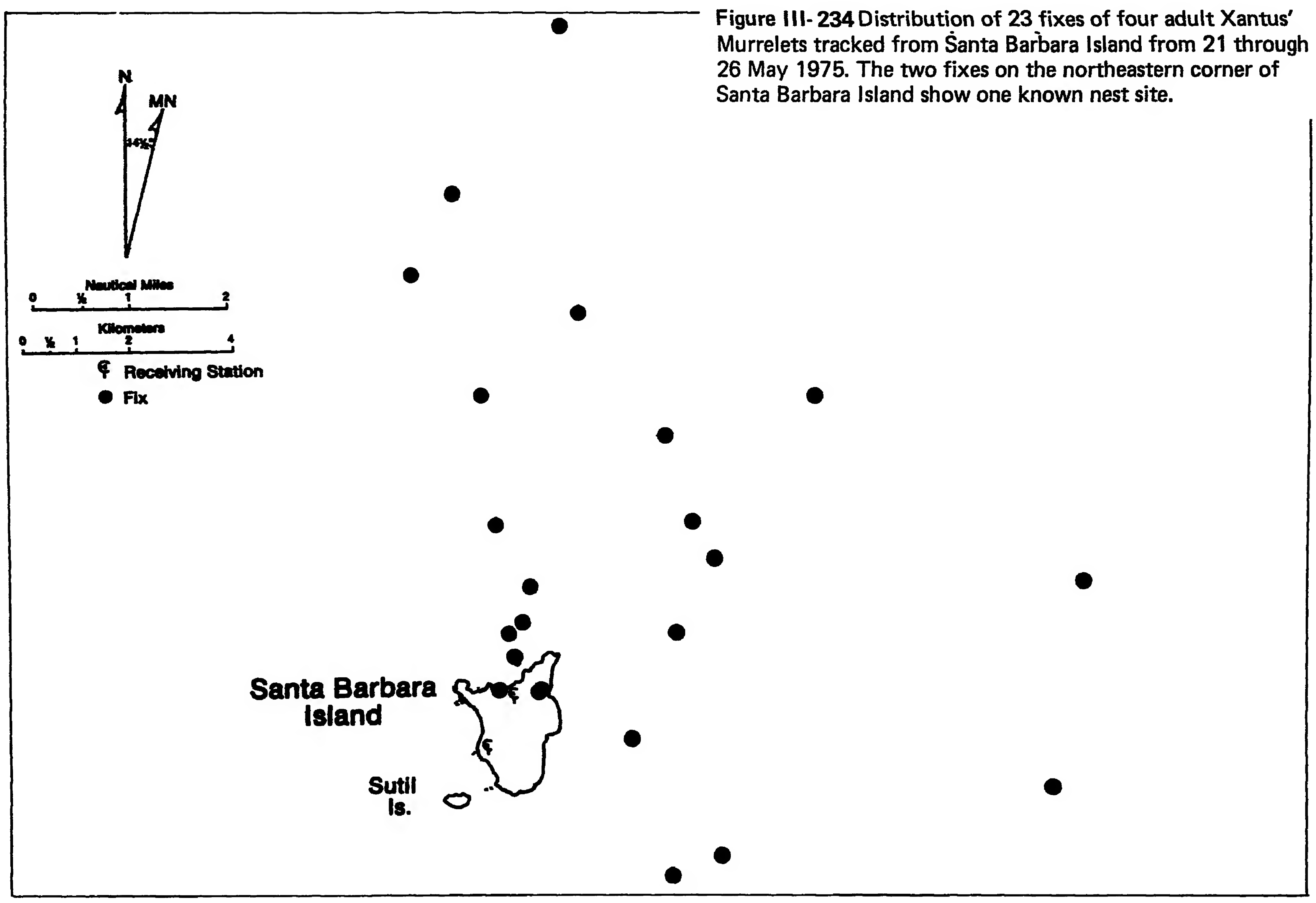


Figure III-234 Distribution of 23 fixes of four adult Xantus' Murrelets tracked from Santa Barbara Island from 21 through 26 May 1975. The two fixes on the northeastern corner of Santa Barbara Island show one known nest site.

of Santa Barbara Is.

We obtained tracks consisting of several sequential fixes from three murrelet subjects that bear upon the problem of daily activity schedules at sea. One bird (no. 4541, Fig. III-235) was followed on 23 and 24 May in the morning and afternoon respectively. The morning track moved away from the island between 1018 and 1150 then northwest until 1250, after which contact was lost. The afternoon track approached the island from the north between 1135 and 1510. This bird had a nest on the northeast corner of Santa Barbara Island.

We tracked a second murrelet, no. 4544, on 24 May between 0805 and 1835 (Fig. III-236). The bird was approximately 11.5 km (6.2 NM) east at 0845 when initial contact was established. It moved northwest, then moved to near the north face of the island at 1145. Subsequent fixes showed first slow, then rapid movement to the north as darkness approached. Bird no. 4543 was tracked on the same day between 0800 and 1925. It proceeded in much the same way as the previously described bird, but remained closer to the island at all times (Fig. III-236). We were uncertain of the breeding status of both these subjects as they were mist-netted at night.

These tracks suggest that Xantus' Murrelets from Santa Barbara Is. concentrate preferentially north and east of the colony and may dramatically change their bearing and proximity to the colony in a few hours time. An out-in rhythm of (presumed) foraging movements was suggested by three of the tracks. Murrelets moved at least 10.9 km (5.9 NM) to 12.0 km (6.5 NM) from the colony, and the possibility of more extensive movement cannot be excluded.

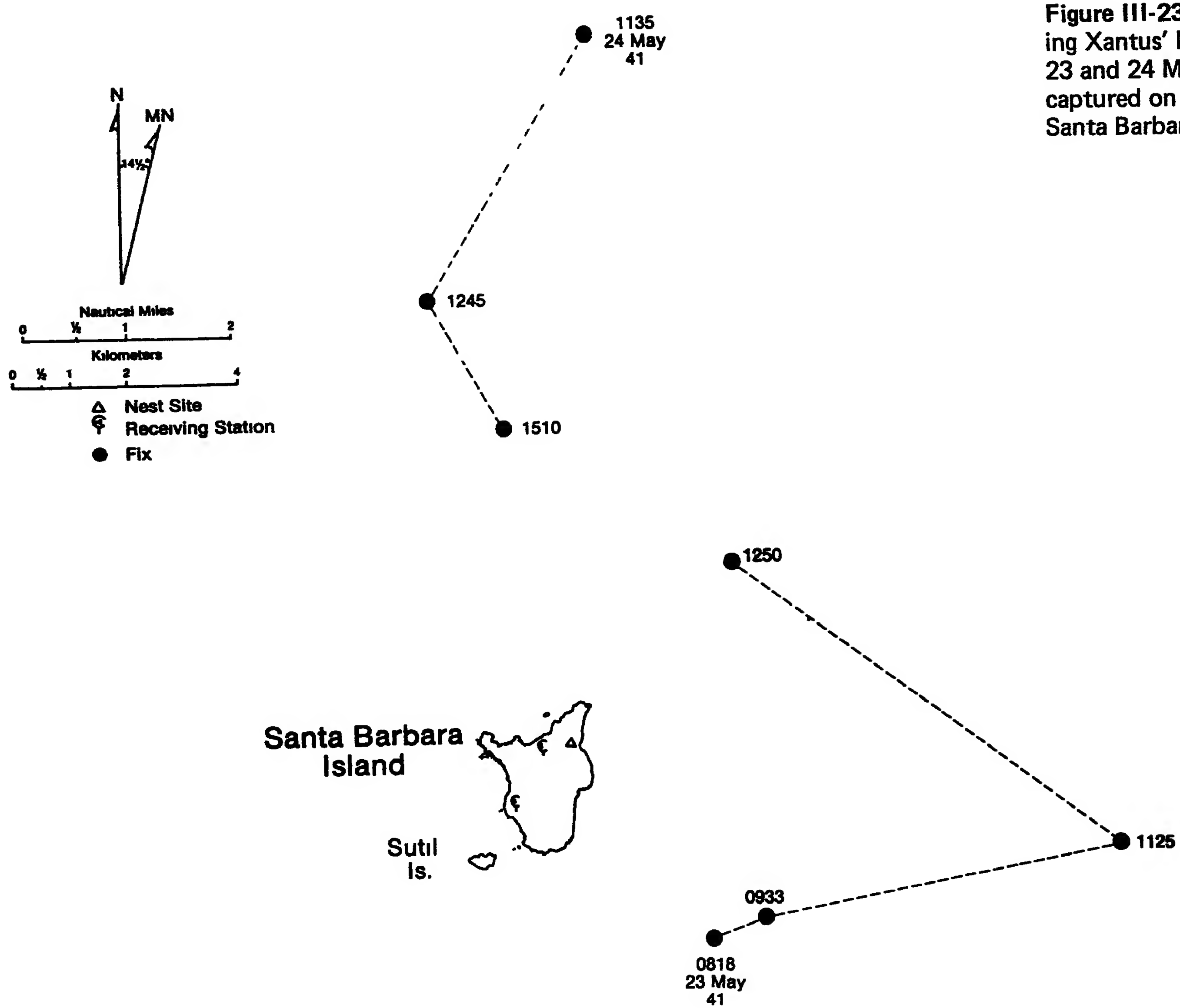


Figure III-235. Movements of a nesting Xantus' Murrelet (No. 4541) on 23 and 24 May 1975. The bird was captured on a nest on northeastern Santa Barbara Island on 22 May.

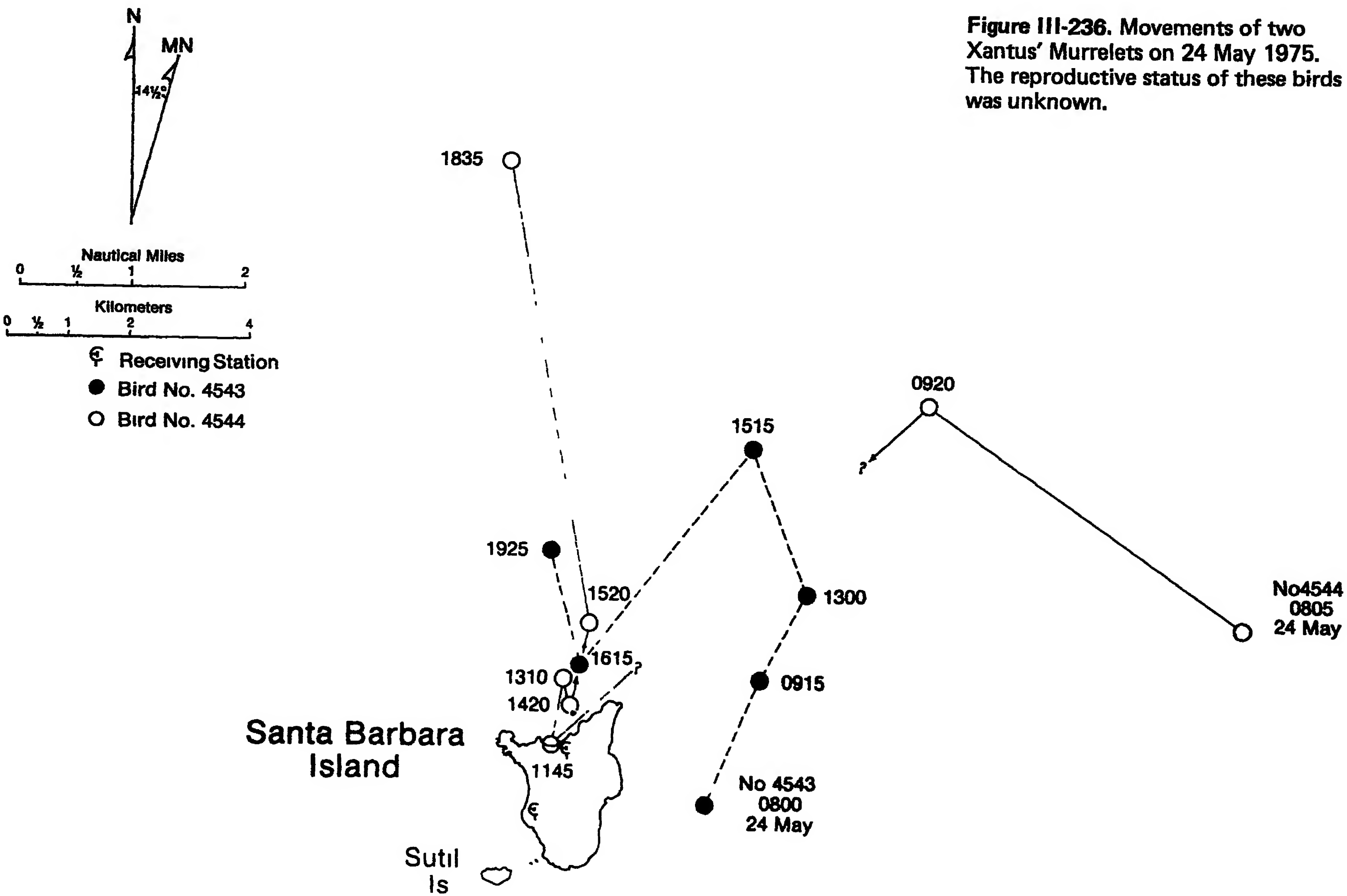


Figure III-236. Movements of two Xantus' Murrelets on 24 May 1975. The reproductive status of these birds was unknown.

b. San Miguel Island

Western Gulls: We tracked gulls near San Miguel Is. from 30 May through 2 June. Winds were generally NW, 10-30 km/hr after 1200 each day and somewhat less strong before noon. High fog persisted throughout the study except on 31 May which was clear.

As was the case with birds on Santa Barbara Is., the Western Gulls captured on Prince Is. spent most of the daylight hours on land; 161 of 194 total fixes (83.0%) were on the colony (Fig. III-237). Ten fixes (29.4% of 34 off-colony fixes) came from the waters within less than 1.85 km (1 NM) of the colony, an additional five from Cuyler Harbor beaches, and one each from Cardwell Pt. and Harris Pt. Nine fixes (26.5% of off-colony total) came from waters between 1.85 and 4.6 km (1-2.5 NM) from the colony. These birds concentrated between Prince Is. and San Miguel Passage and southwest of Cardwell Pt. We made visual observations of several large foraging groups of pinnipeds, Arctic Loons, cormorants and Western Gulls in the area between Prince Is. and San Miguel Passage at the same times that two telemetered gulls flew to the Passage from the vicinity of the nesting colony. It seems probable that our subjects were flying to join the foraging activity.

More distant fixes of Prince Is. gulls came from west of Richardson Rk., between Prince Is. and Brockway Pt., Santa Rosa Is. (two fixes), and along an arc from near Gaviota on the mainland to north of Carrington Pt., Santa Rosa Is. (Fig. III-238).

All of the fixes more distant than 14.8 km (8 NM) came from one male, no. 4540, on 30 May and on 1 and 2 June (Fig. III-239). The distant fix on 30 May (1740 hours) was approximately 9.25 km

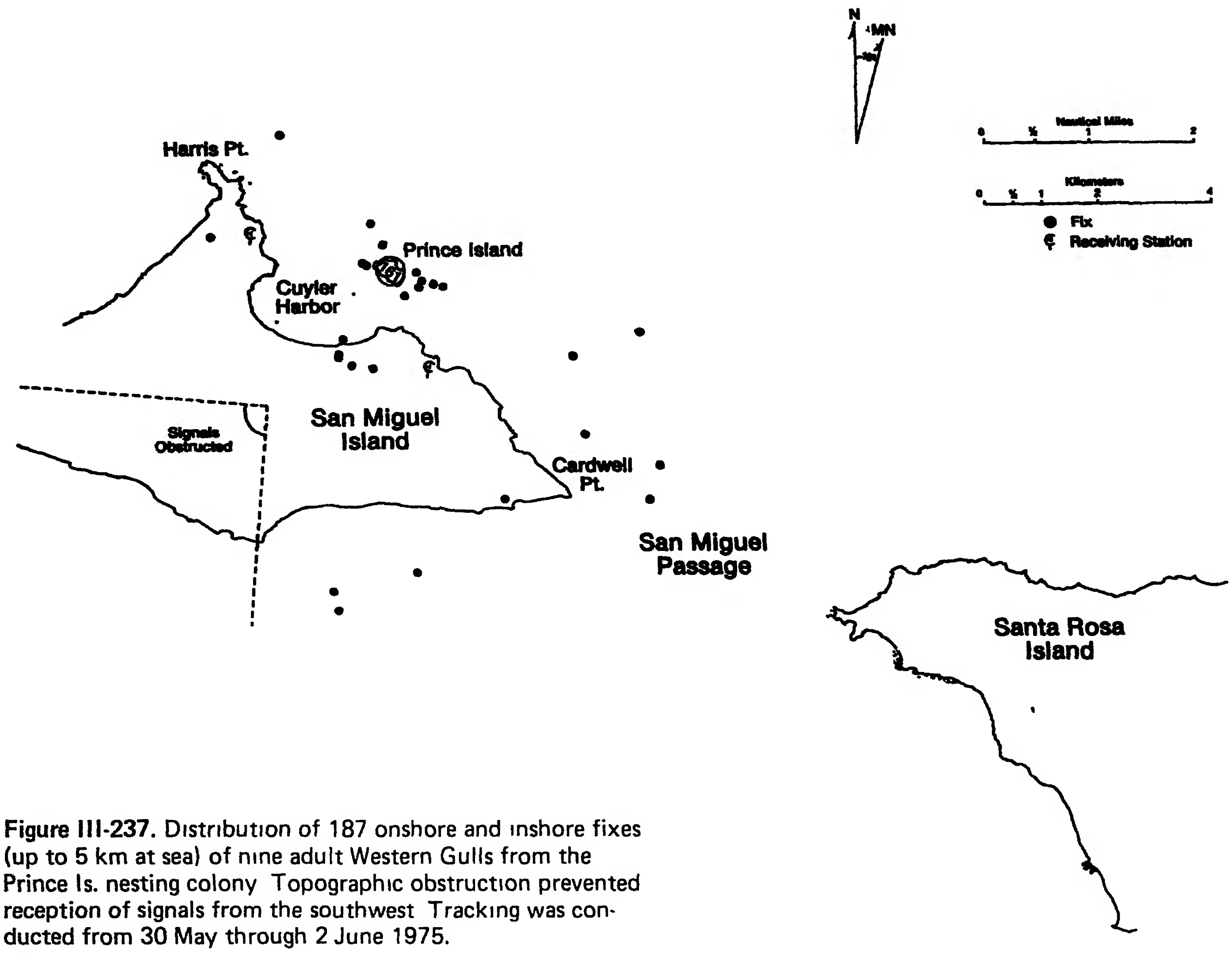


Figure III-237. Distribution of 187 onshore and inshore fixes (up to 5 km at sea) of nine adult Western Gulls from the Prince Is. nesting colony Topographic obstruction prevented reception of signals from the southwest Tracking was conducted from 30 May through 2 June 1975.

Figure III-238. Distribution of eight distant fixes (>5 km at sea) of three adult Western Gulls from Prince Island.

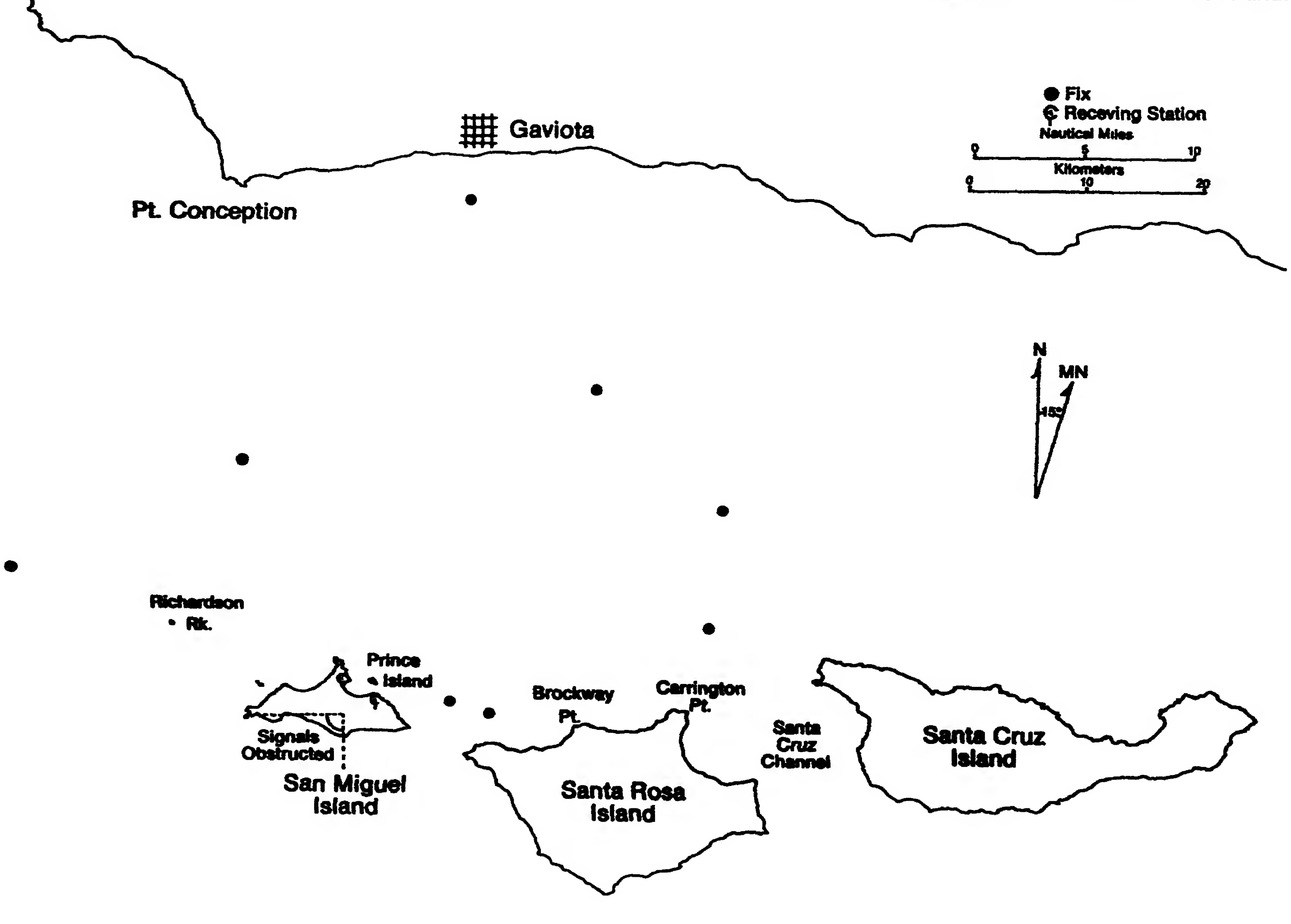
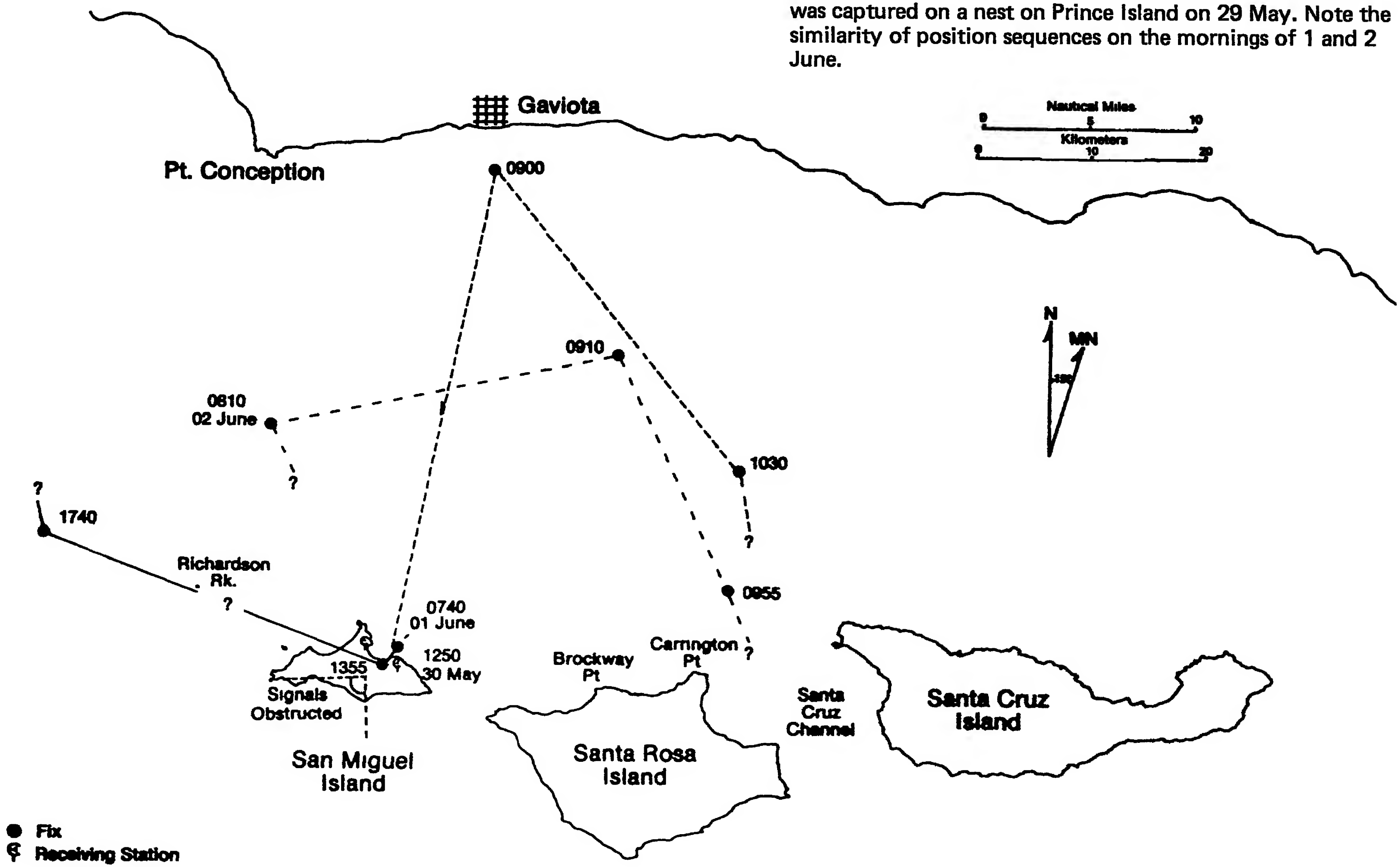


Figure III-239. Movements of an adult (presumed male) Western Gull on 30 May, and 1 and 2 June 1975. The bird was captured on a nest on Prince Island on 29 May. Note the similarity of position sequences on the mornings of 1 and 2 June.



(5 NM) north of Santa Cruz Channel 90 minutes later. Contact was lost after 1030. A similar pattern was recorded on 2 June, although the bird did not approach the mainland but rather turned east then southeast and once again ended up in the general area of Carrington Pt.-Santa Cruz Channel. Contact was lost after 0955 on 2 June. The similarity of the patterns of movement exhibited on 1 and 2 June is remarkable and suggests a foraging sequence. The rapidity with which the bird moved between the indicated locations (approximately 27.7 km/hr [15 knots] for 2.8 hours on 1 June, and approximately 31 km/hr [16.8 knots] for 1.8 hours on 2 June) probably precluded much feeding activity.

The results of our banding efforts are presented in Tables III-147 and III-148. As the number of banded birds increases with subsequent years of study, we should begin to obtain recaptures and returns of bands from birds found dead.

D. Discussion

In the first year's study of foods and foraging areas used by seabirds nesting in the Channel Islands of southern California, we have attempted to document, via the literature and data gathered in the field, aspects of the foraging ecology of these marine birds which might affect their vulnerability to oil pollution.

With the exception of the Western Gulls, all species depend exclusively upon foods obtained from the sea. Although we have been as yet unable to obtain food samples from Ashy Storm-Petrels, Ainley et al. (1974) mention that these birds eat small fish and cephalopods. Bent (1922) provides no useful information on this species.

Table III-147 Summary of birds banded/island.

Island	Species	No. birds/age	Date
Prince Is., San Miguel	Ashy Storm-Petrel	5 adults	13 May 1975
	Brandt's Cormorant	6 chicks	19 June 1975
	Xantus' Murrelet	3 adults	13 May 1975
	Cassin's Auklet	19 chicks	13 May 1975
		26 adults	
	Western Gull	3 adults	28 May 1975
		61 chicks	18 June 1975
San Nicolas	Brandt's Cormorant	6 chicks	19 June 1975
	Western Gull	55 chicks	11 June 1975
			19 June 1975
Gull Island	Cassin's Auklet	2 adults	18 April 1975
Bird Rk., Santa Catalina	Western Gull	18 chicks	20 June 1975
Anacapa	Western Gull	34 chicks	16 June 1975
			14 July 1975
Santa Barbara	Xantus' Murrelet	55 adults & chicks	Apr.-June 1975
	Western Gull	65 adults	
		191 chicks	May-July 1975

Totals:

Prince Is., San Miguel Is.	123
San Nicolas Is.	61
Gull Is.	3
Bird Rk., Santa Catalina Is.	18
Anacapa Is.	34
Santa Barbara Is.	311
Total banded	550

Table III-148. Summary of birds banded/species.

Species	Total no.	No. birds/age	Location	Date
Ashy Storm-Petrel	5	5 adults	Prince Is.	13 May
Brandt's Cormorant	12	12 chicks	Prince Is. San Nicolas Is.	18 June 19 June
Xantus' Murrelet	58	58 adults & chicks	Prince Is. Santa Barbara Is.	13 May Apr.-June
Cassin's Auklet	48	26 adults 19 chicks	Prince Is.	13 May
		2 adults 1 chick	Gull Is.	 18 Apr.
Western Gull	427	191 chicks 65 adults	Santa Barbara Is.	May-July
		61 chicks 3 adults	Prince Is.	18 June 28 May
		55 chicks	San Nicolas Is.	11&18 June
		34 chicks	Anacapa Is.	16 June & 14 July
		18 chicks	Santa Catalina Is.	20 June

Total: 550

The data we obtained on the foods of Brandt's Cormorants indicate they forage on fish, at least some of which are kelp and reef dwellers (Table III-139). Bent (1922) records them as using bottom fish, rock cod, and having sardines on the ground around their nests (at Carmel Pt., 1895). Ainley and Lewis (1974) feel that since the demise of the Pacific sardine (Sardinops caerulea) this species forages primarily on bottom fishes. Hubbs et al. (1970) indicate that roosting Brandt's Cormorants near La Jolla, San Diego County, take a wide variety of fish from the kelp beds and surface, midwater and bottom fish from open-water sites. We obtained no data on the foods of either Double-crested or Pelagic Cormorants. Wright (1913) and Bent (1922) mention that Double-crested Cormorants made use of Pacific sardines, and Ainley and Lewis (1974) believe that the decrease in Double-crested Cormorant populations may be at least partly explained by the demise of this fish. Little or no information is currently available on the foods of the Pelagic Cormorant.

Our data on the foods of Western Gulls fit well with the findings of Hunt and Hunt (1976b). These birds feed their chicks almost entirely with natural foods; only birds on Anacapa were found to provide "garbage" for their young. Interestingly however, incubating adult Western Gulls will take garbage: our studies of color-marked gulls revealed that birds from Santa Barbara Is. forage at a large Los Angeles County dump located on the Palos Verdes Peninsula. Schreiber (1970) found that Western Gulls on San Nicolas Is. feed on California sea lion (Zalophus californianus) placentae as well as on fish, crabs, snails and squid.

The types of natural foods we found were almost exclusively those which would be obtained from the ocean by plunge-diving. The Western Gulls from which we obtained samples took virtually no intertidal foods, and if a large oil spill occurred, it could diminish access to their normal food supply. Although relatively few adults are likely to become oiled, if a spill occurred during the breeding season it could force gulls to seek food over greater distances. Delays in the feeding of young caused by this increase in commuting time would very likely seriously affect reproductive success (Hunt 1972, Hunt and McLoon 1975, Hunt and Hunt 1976a).

During the 1975 breeding season we obtained no food samples from Pigeon Guillemots, Cassin's Auklets or Xantus' Murrelets. However, Drent's (1965) excellent study of Pigeon Guillemots in British Columbia showed that in 514 cases this species took 99% fish and 1% shrimp at Mandarte Is. Of the fish delivered to young, 70% were blennies and sculpins. The foods of Cassin's Auklets have been studied by Manuwal (1974a) on Southeast Farallon Is. He obtained and analyzed the contents of the gular pouches (Speich and Manuwal 1974) of 22 adults that were bringing food to young. These consisted of euphausiids 91%, squid 35%, amphipods 55%, and other 36%, by percent occurrence in samples. Up to 269 euphausiids and 2045 amphipods were found in the same sample. Thoresen (1964) also indicates that euphausiids predominate and that small fish are also present in the diets of Cassin's Auklets.

We know of no published information on the foods of Xantus' Murrelets. Bent (1919) quotes Howell who surmises that the murrelets

eat small crustaceans, but he gives no data.

Our data on the distribution of foraging areas used by nesting seabirds suggest that birds are distributed in rough zones around their colonies with certain sides of islands being favored over others. Pigeon Guillemots appear to be restricted during their breeding season to inshore portions of kelp beds immediately adjacent to their nesting sites. Similarly, Brandt's Cormorants appeared to confine their foraging to kelp beds near their nesting colonies, although they also frequently foraged in large flocks within a nautical mile or two of the nesting islands. This species generally was not found foraging in deep water.

In contrast, both Xantus' Murrelets and Cassin's Auklets appeared to concentrate their foraging in bands 1.85-5.5 km (1-3 NM) and 7.4-14.8 km (4-8 NM), respectively, from their nesting colonies. However, due to the presence of large numbers of non-breeding birds in the populations of these two alcids, we have yet to determine that the foraging areas of birds which are actively involved with nesting are the same as for the population as a whole. It is also presently unclear whether the apparent bands of concentration of these two small alcids exist because of oceanographic features which may concentrate food.

Cassin's Auklets from Prince Is. concentrated their foraging to the north of San Miguel Is. Very few were seen between Prince Is. and Santa Rosa Is., or south of Crook Pt. Within the Santa Barbara Channel, most auklets appeared to be in fairly shallow water or near the edge of deeper water, although at present our data are too

meager to substantiate this possible relationship.

Western Gulls were found to forage over a wide range of areas, including areas close to their islands, far at sea and on the mainland. Both the radio-tracking and color-marking methods revealed movements of this species which could not have been detected by radial ship transects alone.

In the vicinity of Santa Barbara Is. both gulls and murrelets appeared to concentrate their at-sea activities to the north, northeast and east of the island. Very few radio-tracking fixes or radial transect observations for either species came from the areas to the south except that color-marked gulls were seen at Osborn Bank. Most radio-tracking fixes were relatively close to the island (less than 5.5 km [3 NM]), an area of relatively shallow water (50 to 150 m). The more distant radio-tracking fixes were distributed along the crowns and sides of two sea floor ridges; one ridge forms a broad, deep shelf between Santa Barbara and Anacapa islands, the other connects Santa Barbara and Santa Catalina islands. These and other ridges in the study area have been identified (Jones 1971) as having an influence on mid- and deep-water circulation in the area: they interrupt and channel mid- and deep-water circulation and may affect productivity on a local scale. The possibility of local current anomalies related to sea floor topography leading to increased productivity and through the marine food chain affecting concentration of seabirds needs to be examined. Unfortunately, detailed data on the availability of seabird foods near the banks and ridges north and east of Santa Barbara Is. are lacking at present.

Western Gulls from the San Miguel (Prince Is.) colony concentrated their at-sea activities in the Prince Is.-San Miguel Passage area and to the southeast of Crook Pt. and were more scattered at greater distances to the northwest, north and northeast of the colony. Once again, most radio-tracking fixes came from shallow water areas (less than 150 m), with only 5 of 18 at-sea fixes (all from one wide-ranging bird) being from deep water.

Too few data were obtained for Ashy Storm-Petrels, Double-crested and Pelagic Cormorants and Brown Pelicans for us to say anything about their foraging and feeding habits in the study area at this time.

SECTION IV
SEABIRDS

Chapter IV
Beached Birds Survey

D. B. Lewis and G. L. Hunt, Jr.

III. BIRDS: Beached Birds Survey

A. Introduction

The object of the present study was to provide baseline information on the rate of beaching of birds in southern California and to provide an estimate of the incidence of oiling of the beached birds.

Surveys of beaches for dead and dying seabirds provide a simple method for obtaining an index of seabird mortality. For this reason beachwalks to count oiled seabirds frequently have been conducted subsequent to massive oil spills (for western North America - Aldrich 1938, Moffitt and Orr 1938, Richardson 1956, Straughan 1971, Smail et al. 1972).

The interpretation of the results of beachwalks following oil spills have been complicated by at least two factors: the lack of baseline information on normal rates of mortality and incidence of oiling, and the lack of a means of relating the numbers of birds found on beaches to the numbers of birds dying at sea.

At any give time there is likely to be a small to moderate number of dead birds washing up on beaches. Some of these birds are likely to be oiled, either after death or prior to death. Nelson-Smith (1973, p. 144) and references cited therein suggest that "chronic pollution probably kills more [seabirds] every year than die after a single catastrophic spill". Thus, in an area supporting an already

large shipping traffic and containing numerous natural oil seeps, if the effect of new oil production is to be assessed, it is critical to obtain baseline data on present levels of seabird mortality and the associated frequency of oiling.

The number of beach-cast seabirds found can only provide a crude index to the total numbers dying at sea. The percentage of birds which wash ashore are variously estimated to represent 5% to 15% of total mortality (Nelson-Smith 1973, p. 144). Hope-Jones et al. (1970) released banded dead murres at sea and found that within four months 20% had been recovered. Thus, while we clearly need additional research before we can relate numbers of beached birds to those dying at sea, we can say that beached birds represent only a small minority of those dying at sea.

The species' composition of oiled birds which are beach-cast should reflect not only the relative numbers of each species using the offshore waters, but also the differential vulnerability of the species to oiling. Diving birds are notably susceptible to oiling (Bourne 1968a, 1968b; Clark 1973; Vermeer and Anweiler 1975). G. Sanger (pers. comm.) has developed an index of vulnerability for marine birds of the eastern subarctic region of the north Pacific. He uses eleven different characteristics to define the vulnerability of a species' total population. When these criteria are applied to seabirds in southern California, not only are the diving birds and phalaropes expected to have a high vulnerability, but also the albatrosses, shearwaters, storm-petrels, pelicans. and gulls and terns are seen as groups of species for which a major oil spill would constitute a serious

threat. Some, such as the albatrosses and storm-petrels are unlikely to wash up on beaches due to their small numbers of offshore distribution. In contrast, on the basis of large numbers of loons and grebes washed ashore, Connell (1971) estimated that over half of the Santa Barbara Channel populations of these species may have been killed in the Santa Barbara spill.

While beached birds surveys have been a regular feature of European studies for over two decades (Tanis and Bruijns 1968; Goethe 1968; Bourne and Devlin 1969, 1970, 1971; Bibby and Bourne 1971; Hald-Mortensen 1971) regular surveillance of North American beaches has only recently been initiated. In California, Point Reyes Bird Observatory (PRBO) began surveys of several beaches in the north and central part of the state in 1970; in 1975 they expanded these efforts to include some beaches in southern California (D. Ainley, PRBO, pers. comm.).

The present study was initiated to provide the necessary baseline data on beached birds in southern California.

B. Methods

Surveys of beached dead seabirds were made from April 1975 through April 1976 on 18 southern California beaches between Ventura and the Mexican border (Fig. III-240) and on Santa Cruz Is. (Fig. III-241). Beach locations, frontages, survey frequencies, and methods are summarized in Table III-149. Generally, mainland beaches were surveyed monthly by four-wheel drive vehicles provided by California State Beaches and Parks personnel. We were driven slowly along the berm by a ranger or lifeguard while we scanned the beach from the waterline to the highest monthly tidal swash. Inspection of adjacent flats was necessary on Santa Cruz Island since foxes or ravens often dragged seabird carrion off the beaches. Beaches of the Pacific Missile Test Center (PMTC), much of Santa Cruz Island, and portions of Point Mugu State Beach were inspected monthly on foot. Additionally, personnel at Point Mugu, Dockweiler, and Border Field State Beaches often supplied birds encountered during their normal tours of inspection. Approximately 10 linear km of Orange County beaches were inspected daily (Monday through Friday) by Orange County Public Health Department employees while on their regular water sampling regimen. Data from Orange County are treated separately since they were not obtained directly by us and since surveys were conducted daily and not monthly.

All dead seabirds encountered were identified, examined for oiling, and removed from the beach after the data were recorded. Notes on plumage, extent of decomposition and location on beach frontage were taken. Birds collected by park or county personnel were tagged, bagged and held for our retrieval. In situ photographs of carcasses collected by us were made on 35mm color slide film, beginning in August.

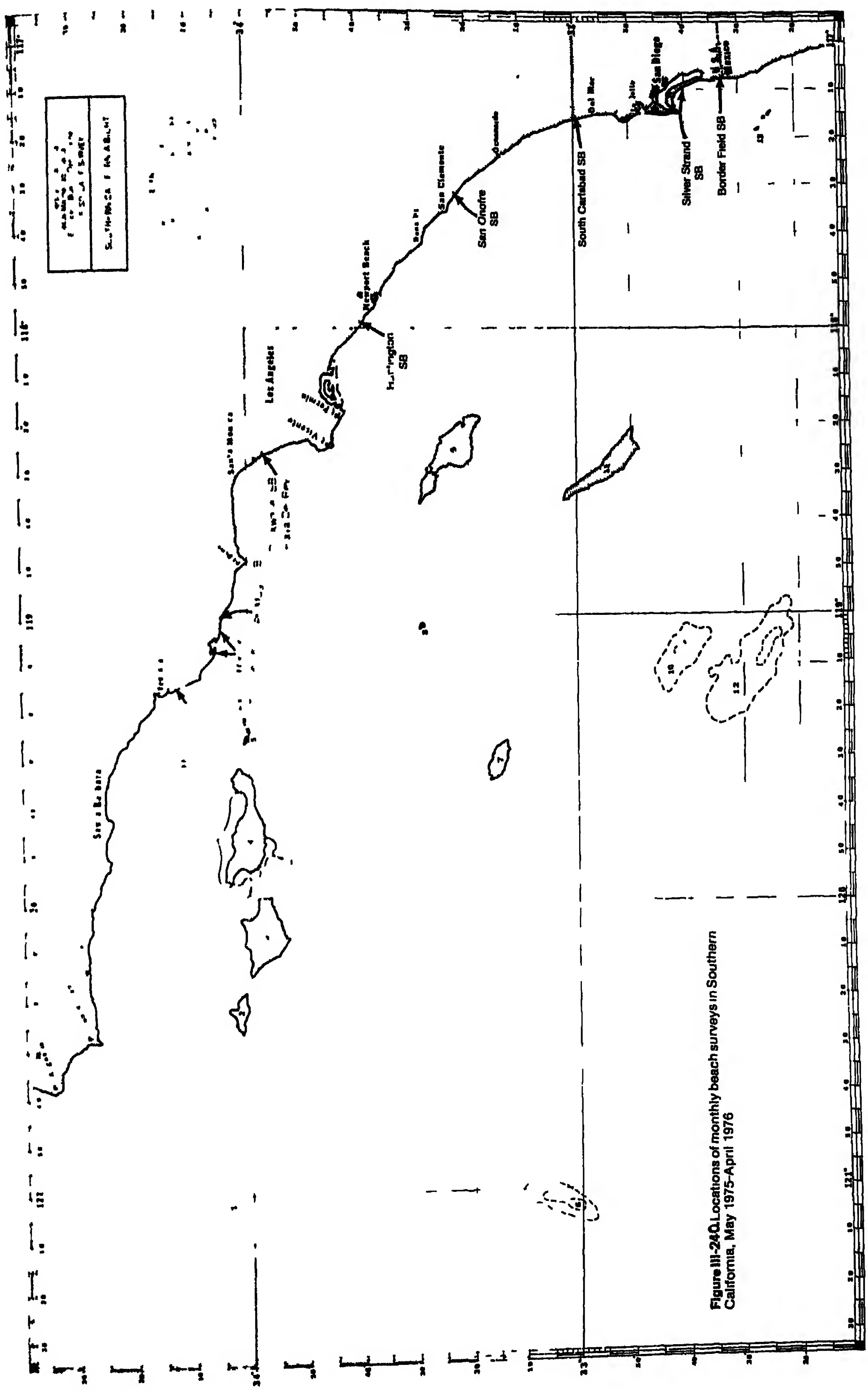


Figure III-240. Locations of monthly beach surveys in Southern California, May 1975-April 1976

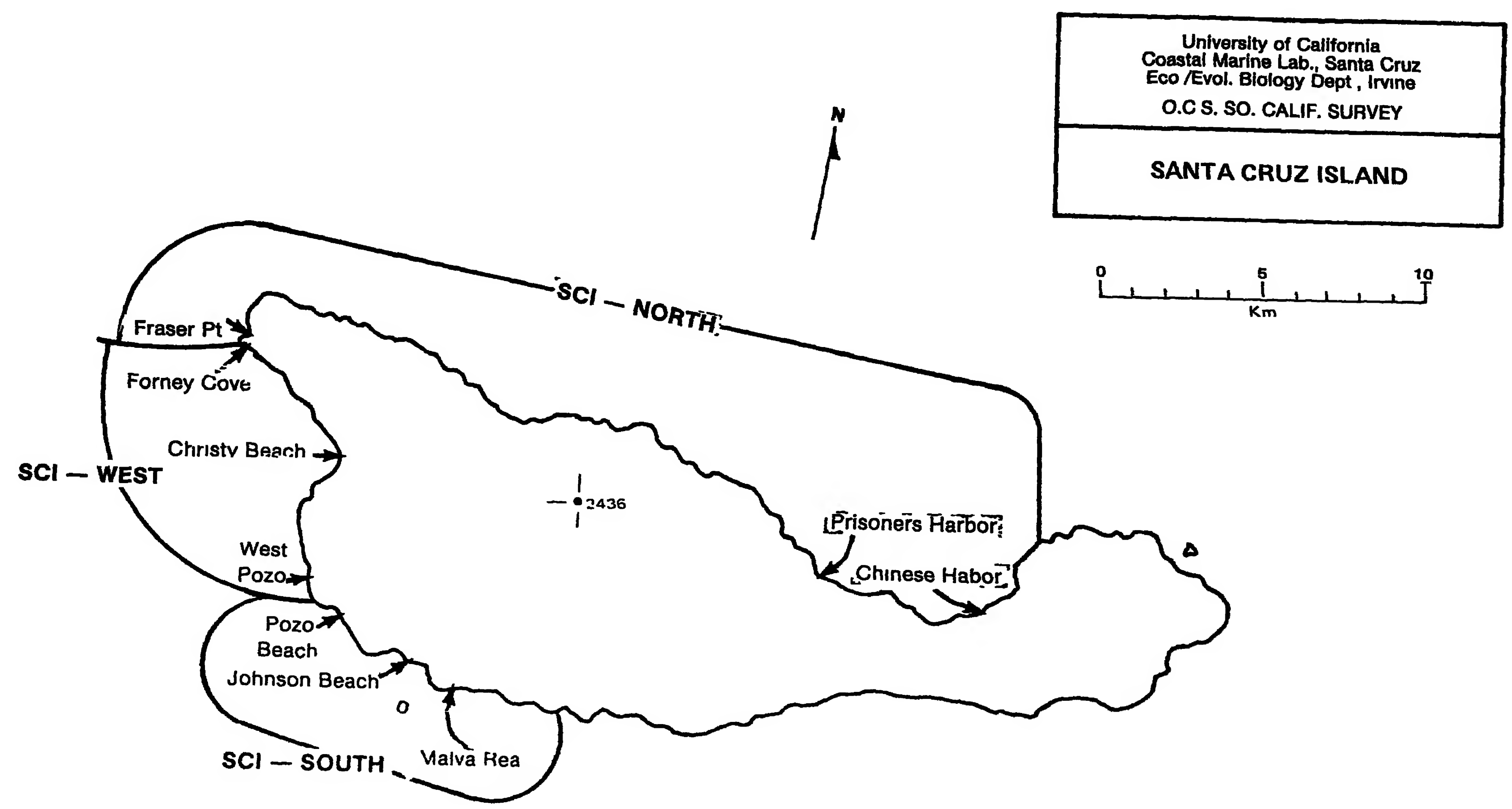


Figure III-241. Locations of monthly beach surveys on Santa Cruz Island May 1975-April 1976.

Table III-149. Beach survey summary by location, May 1975 through April 1976.

	Beach		Beach frontage km	Surveys	Total frontage surveyed 75-76 (km)	Birds found	Average # birds/km/ month	Percent oiled	Total species
	Mainland								
NORTH	McGrath S.B.	(McG)	3.0	12	36.0	80	2.22	46.3	16
NORTH	Pacific Missile Test Center	(PMTC)	3.1	10*	31.0	84	2.71	25.0	24
NORTH	Pt. Mugu S.B.	(PtM)	3.3	12	39.6	41	1.04	22.0	19
CENTRAL	Dockweiler S.B. (=Playa del Rey)	(PDR)	5.6	12	67.2	73	1.09	27.4	19
CENTRAL	Huntington S.B.	(HUN)	3.3	12	39.6	62	1.57	19.4	10
CENTRAL	San Onofre S.B.	(SOn)	5.0	12	60.0	29	0.48	20.7	08
SOUTH	South Carlsbad S.B.	(SoC)	9.3	12	111.6	93	0.83	12.9	13
SOUTH	Silver Strand S.B.	(SSd)	5.7	12	68.4	134	1.99	13.2	19
SOUTH	Border Field S.B.	(BFd)	2.6	12	31.2	55	1.70	11.3	10
	MAINLAND TOTAL		40.9		484.6	651	1.34	21.9	42
	Santa Cruz Island								
	North	(SCI-N)	4.3	12*	48.0	140	2.92	56.4	25
	West	(SCI-W)	4.2	12*	48.0	72	1.50	36.1	18
	South	(SCI-S)	5.7	12	68.4	14	0.20	07.1	07
	ISLAND TOTAL		14.2	12*	164.4	226	1.37	46.9	31
	TOTAL		55.1	12*	649.0	877	1.35	28.4	49

* Pacific Missile Test Center was not surveyed in May and June 1975; Santa Cruz Is. North and West surveys were incomplete in October 1975.

Birds were considered "oiled" if any petroleum products or residues could be detected on the plumage, including incidental tar or crude oil picked up post-mortem while floating or from the beach itself.

Additionally, mortality that was felt to be directly attri-buatable to oiling was recorded as "oil soaked". Oil soaked birds were distinguished by oil-stained plumage of the belly and breast, usually at the waterline, penetrating to the downy under-plumage. The oil on these birds had to be in appropriate amounts and locations to suggest that not only had they first encountered the oil while alive, but that the oiling had been sufficient to cause death. Since complete necropsies were not performed on the birds, more subtle oil-caused mortality such as the ingestion of preened oil globules was not determined. The "oil soaked" category therefore probably understates the actual incidence of oil-caused mortality in our sample.

C. Results

A total of 649 km of monthly surveys was conducted on 18 southern California beaches over a twelve month period from May 1975 through April 1976 (Table III-149). Of this total, 485 km were conducted on nine mainland beaches between Ventura and the Mexican border. The remaining 164 km of surveys were done on nine beaches on Santa Cruz Is. In addition the Orange County Sanitation District surveyed 2,184 km of beach on 260 days between 1 June 1975 and 31 May 1976.

A total of 877 beach-cast birds of 49 species was found on the monthly surveys. (Table III-150) for an overall average of 1.35 birds/km/month. Of these, 651 individuals of 42 species were encountered on the mainland beaches, with 226 birds of 31 species found on Santa Cruz Is. In addition 363 birds of 19 species were collected by the Orange County Sanitation District between June 1975 and May 1976 and given to us (Table III-151).

Oil was found on the plumage of 28% of the birds encountered on our beach surveys (mainland beaches 22%, Santa Cruz Is. 47%). Seven percent of birds from Orange County beaches were oiled. Oiling was judged to be the cause of death in 9% of all birds from our surveys. No estimate for oil-caused deaths was made for Orange County birds. Other causes of mortality which could be identified included 4 birds with fishing hooks, 10 with apparent shotgun wounds, and 2 birds entangled in plastic six-pack holders.

The number of beach-cast birds varied seasonally and by beach (Fig. III- 242 and 243). Monthly beached-bird sightings were highest in the spring (2.38 birds/km/month, March - May; peak 4.16/km/month in

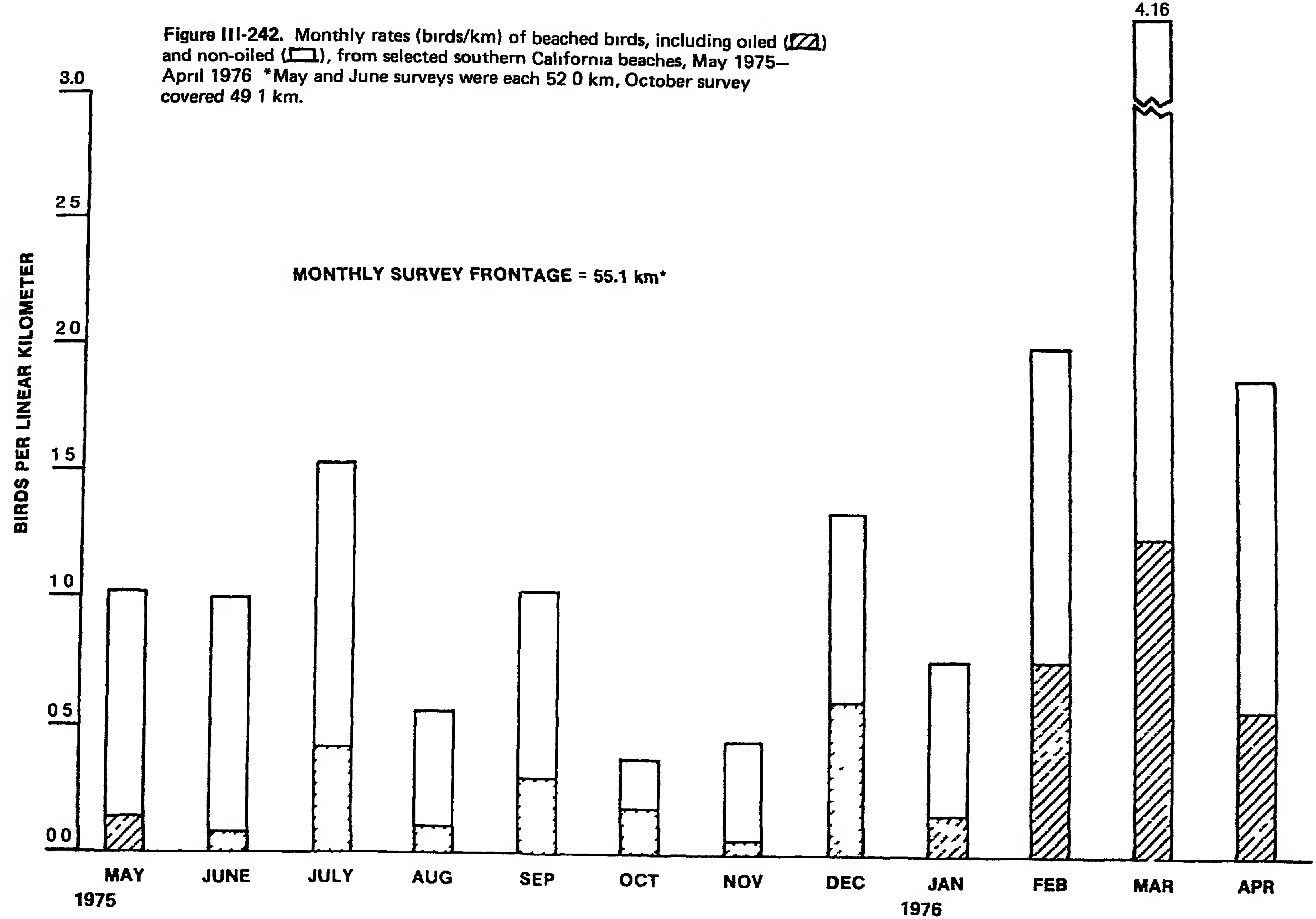
Table III-150. Beached bird summary from monthly surveys of selected southern California beaches, May 1975 - April 1976. See Appendix III-A5 for complete species list.

	Number found	Percent of total	Birds/km/ month	Percent oiled
Arctic Loon	20	2.3	.031	45.0
Other Loons (2)	15	1.7	.023	53.3
Western Grebe	31	3.5	.048	35.5
Other Grebe(s)	17	1.9	.026	29.4
Northern Fulmar	215	24.5	.331	32.1
Sooty Shearwater	117	13.3	.180	35.9
Other Shearwaters (2)	6	0.7	.009	0.0
Ashy Storm-Petrel	1	0.1	.002	0.0
Brown Pelican	11	1.3	.017	18.2
Brandt's Cormorant	24	2.7	.037	8.3
Other Cormorants (2)	15	1.7	.023	33.3
Scoters (2)	19	2.2	.029	21.1
Other Waterfowl (8)	23	2.6	.035	4.3
Shorebirds (5)	11	1.3	.017	45.5
Red Phalarope	2	0.2	.003	0.0
Parasitic Jaeger	2	0.2	.003	0.0
Western Gull	124	14.1	.191	12.9
California Gull	27	3.1	.042	18.5
Black-legged Kittiwake	109	12.4	.168	27.5
Other Gulls (4)	30	3.4	.046	13.3
Tern(s)	3	0.3	.005	33.3
Common Murre	16	1.8	.025	75.0
Xantus' Murrelet	6	0.7	.009	16.7
Other Murrelets (2)	4	0.5	.006	50.0
Rhinoceros Auklet	12	1.4	.018	58.3
Other Alcids (3)	5	0.6	.023	60.0
Other species (2)	12	1.4	.018	25.0
TOTAL	877	100.0	1.351	28.4

Table III-151. Summary of beached birds collected on 8.4 km of Orange County Beaches by the Orange County Sanitation District, June 1975 - May 1976.

	Number found	percent of total	birds per month	percent oiled
Red-throated Loon	1	0.3	0.08	0.0
Western Grebe	14	3.9	1.17	7.0
Other grebes (2)	2	0.6	0.17	0.0
Northern Fulmar	174	47.9	14.50	7.0
Sooty Shearwater	38	10.5	3.17	5.0
Brown Pelican	1	0.3	0.08	0.0
Brandt's Cormorant	3	0.8	0.25	33.3
Surf Scoter	2	0.6	0.17	0.0
American Coot	2	0.6	0.17	0.0
Shorebirds (3)	3	0.8	0.25	0.0
Jaeger (sp.)	1	0.3	0.08	0.0
Western Gull	51	14.0	4.25	2.0
California Gull	15	4.1	1.25	7.0
Black-legged Kittiwake	36	9.9	3.00	19.0
Other gulls	19	5.2	1.58	0.0
Common Murre	1	0.3	0.08	0.0
Total	363	100.0	30.25	7.2

Figure III-242. Monthly rates (birds/km) of beached birds, including oiled and non-oiled, from selected southern California beaches, May 1975–April 1976 *May and June surveys were each 52 0 km, October survey covered 49 1 km.



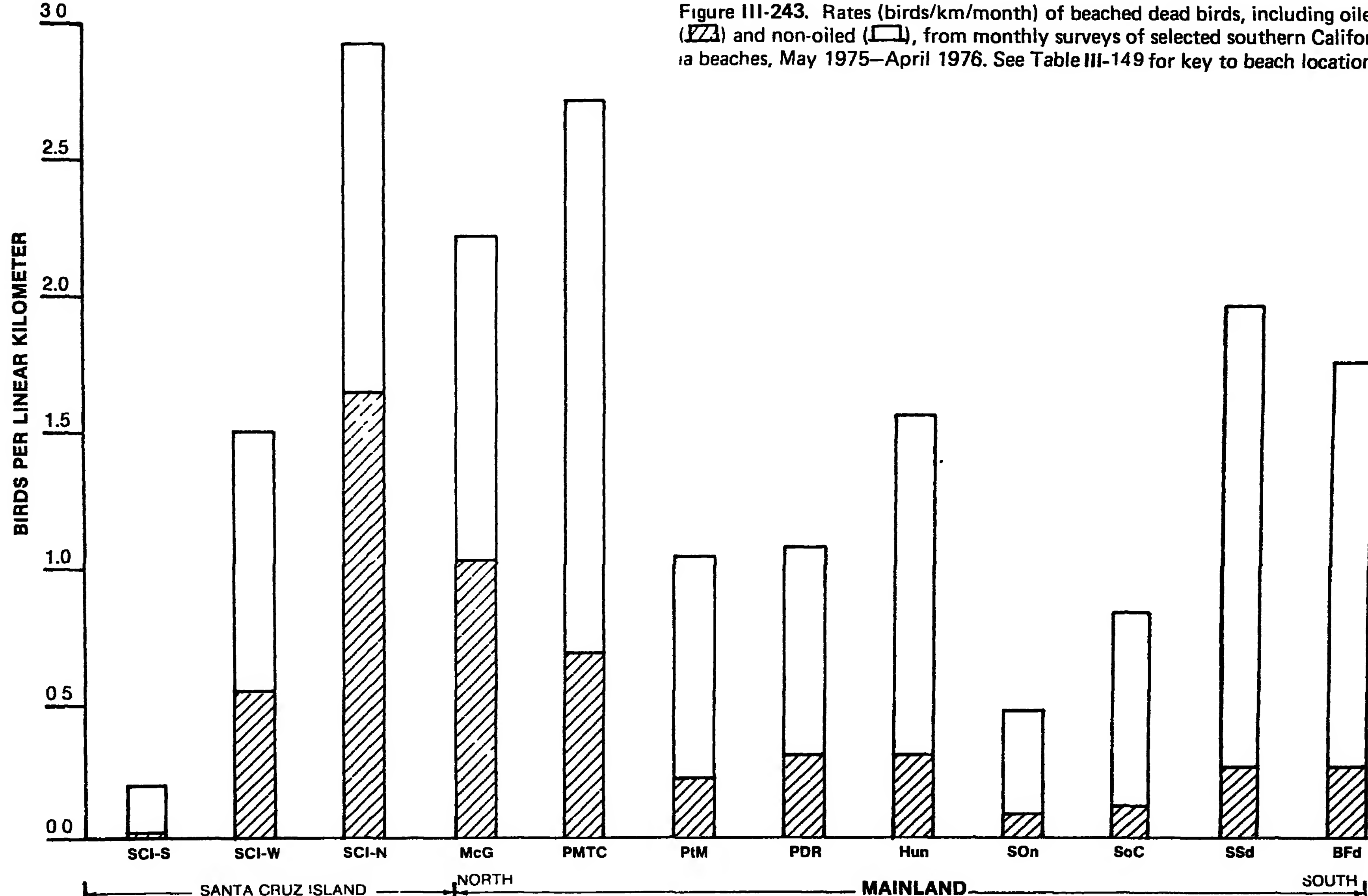


Figure III-243. Rates (birds/km/month) of beached dead birds, including oiled (hatched) and non-oiled (open), from monthly surveys of selected southern California beaches, May 1975—April 1976. See Table III-149 for key to beach locations.

March 1976) and lowest in the summer and fall (0.82 birds/km/month, June - November; minimum 0.37/km/month in October 1975). Moderate counts (1.37 birds/km/month) were found during the winter months of December through February. Beaches on the north and west sides of Santa Cruz Is. and north of Pt. Mugu had larger numbers of beach-cast birds than did beaches between Pt. Mugu and San Diego (Fig. III-243). The north side of Santa Cruz Is. and the Pacific Missile Test Center, Ventura County had the highest rates of beaching, 2.92 birds/km/month and 2.71 birds/km/month respectively. In contrast, the lowest rate of beaching was found on the south side of Santa Cruz Is. (0.20 birds/km/month), the next lowest being at San Onofre State Beach in northern San Diego County (0.48 birds/km/month). On Orange County beaches, the incidence of dead seabirds varied from a high of 112 birds in March to a low of 4 birds in November. The Orange Co. figures are not directly comparable with the other sites, as beaches were checked daily.

Species most commonly found, in order of occurrence, were Northern Fulmar (Fulmarus glacialis), Western Gull (Larus occidentalis), Sooty Shearwater (Puffinus griseus), and Black-legged Kittiwake (Rissa tridactyla), which together comprised 64% of our sample (Table III-150). Loons, grebes, alcids, cormorants, pelicans, other gulls, waterfowl, shorebirds, and other tubenoses accounted for the remaining beach-cast seabirds (see Appendix III-A5 for complete species list).

Species composition varied seasonally (Fig. III-244) and to a lesser extent by beach (Fig. III-245). The concentration of Northern Fulmars,

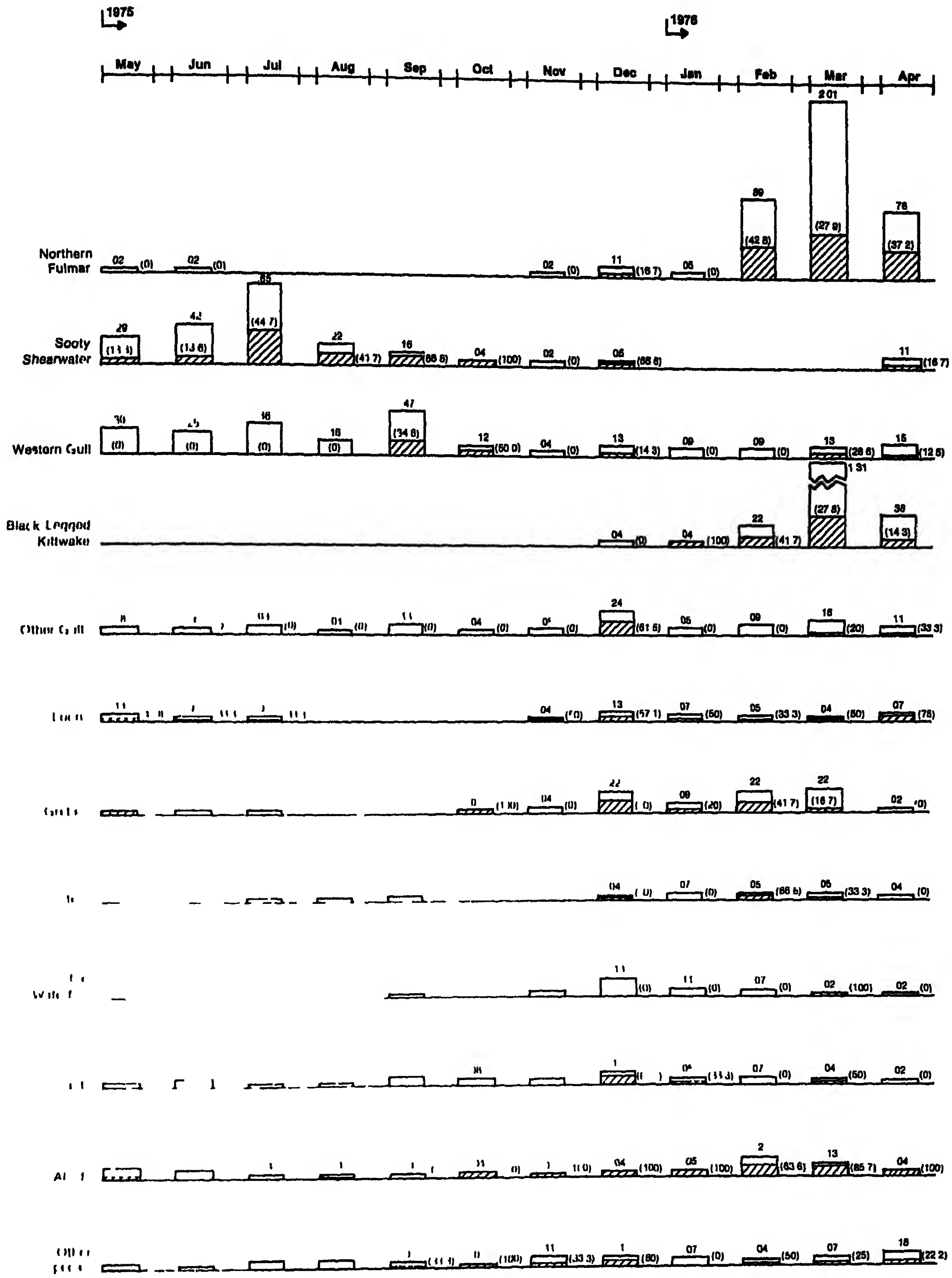


Figure III 244 Monthly distribution of beached bird species from selected southern California Beaches May 1975 April 1976

Total beached bird /km month

Oiled birds (percent of total)

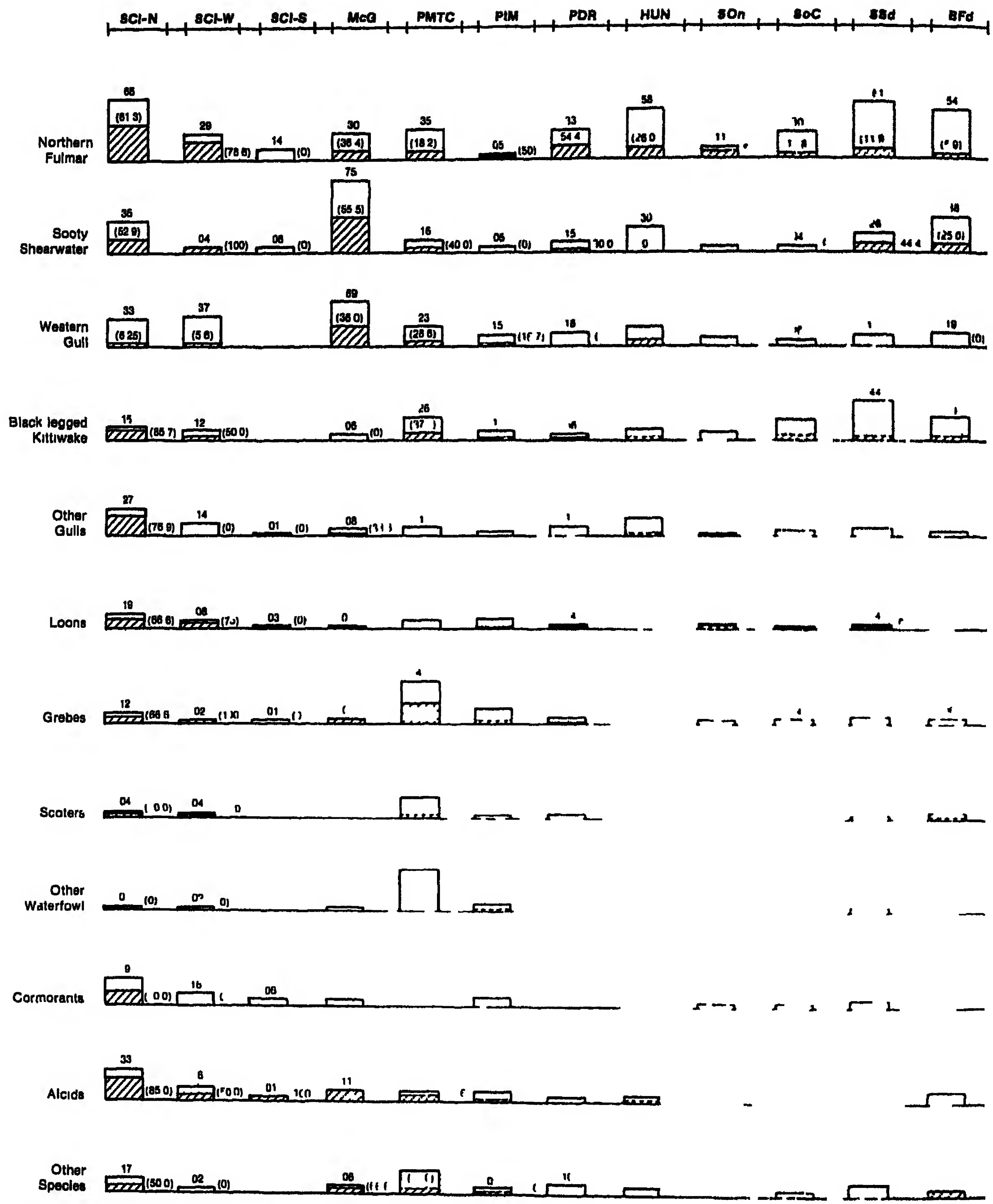


Figure III 245 Regional distributions of beached birds species from selected southern California beaches May 1975 April 1976

Total beached birds km/month

Oiled birds (percent of total)

See Table III 149 for key to beach location codes

Black-legged Kittiwakes, grebes and alcids in the winter months reflected the seasonal nature of their occurrence in southern California waters. The seasonal pattern of Sooty Shearwaters was likewise reflected by the early-summer peak of their mortality.

The frequency of birds with oiled plumage varied by species, by beach and by month. Diving birds such as alcids, loons and grebes were among those most frequently found oiled, but in addition, large numbers of Sooty Shearwaters and Black-legged Kittiwakes were also found with oiled plumage. Surprisingly, shorebirds were also frequently found oiled (45.5%). Oiled scoters, pelicans and cormorants were found in moderate numbers, while gulls other than kittiwakes, terns and jaegers were found oiled less often (15.1%). The remaining species (including coots, herons and estuarine ducks) were seldom oiled. (Table III-150)

The greatest percentage of oiled birds was found on the northern rather than the southern portion of the study area (Fig.III-246). Particularly striking is the difference in the occurrence of oiled birds on the north (56 4) and south (7 1) sides of Santa Cruz Island. Monthly percentages of oiled birds varied between a high of 50/ in October 1975 and a low of 7 / in June 1975, and did not exhibit any clear seasonal trends (Fig.III-247) On Orange County beaches the percentage of oiled birds varied from a high of 21 in April to a low of zero for June and September - February.

Only about 33/ of the oiled birds found during our surveys were believed to have died due to oiling (i.e. oil-soaked). These birds had oil stained plumage on the belly and breast usually at the water line and in amounts and location to suggest that, not only had they first encountered the oil while alive, but that the oiling had been sufficient to cause death. Eighty birds were encountered in this condition, most of which

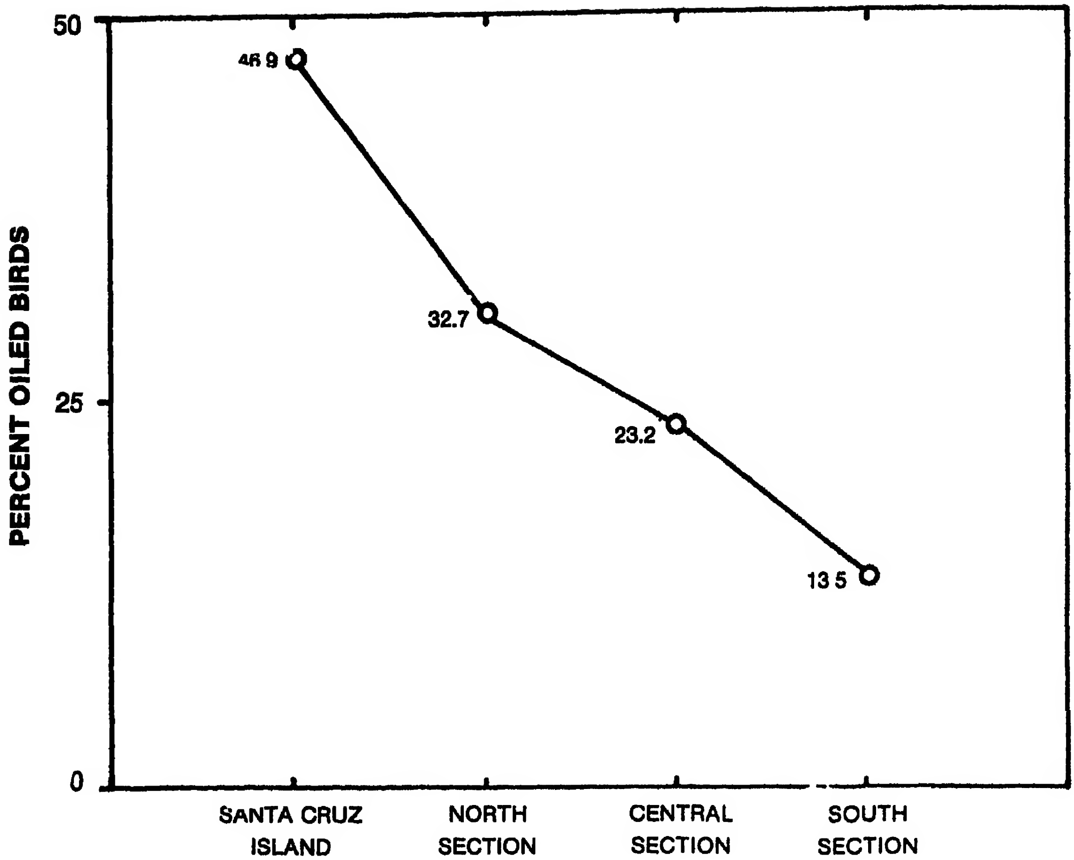


Figure III-246. Percentages of oiled birds, according to region within study area

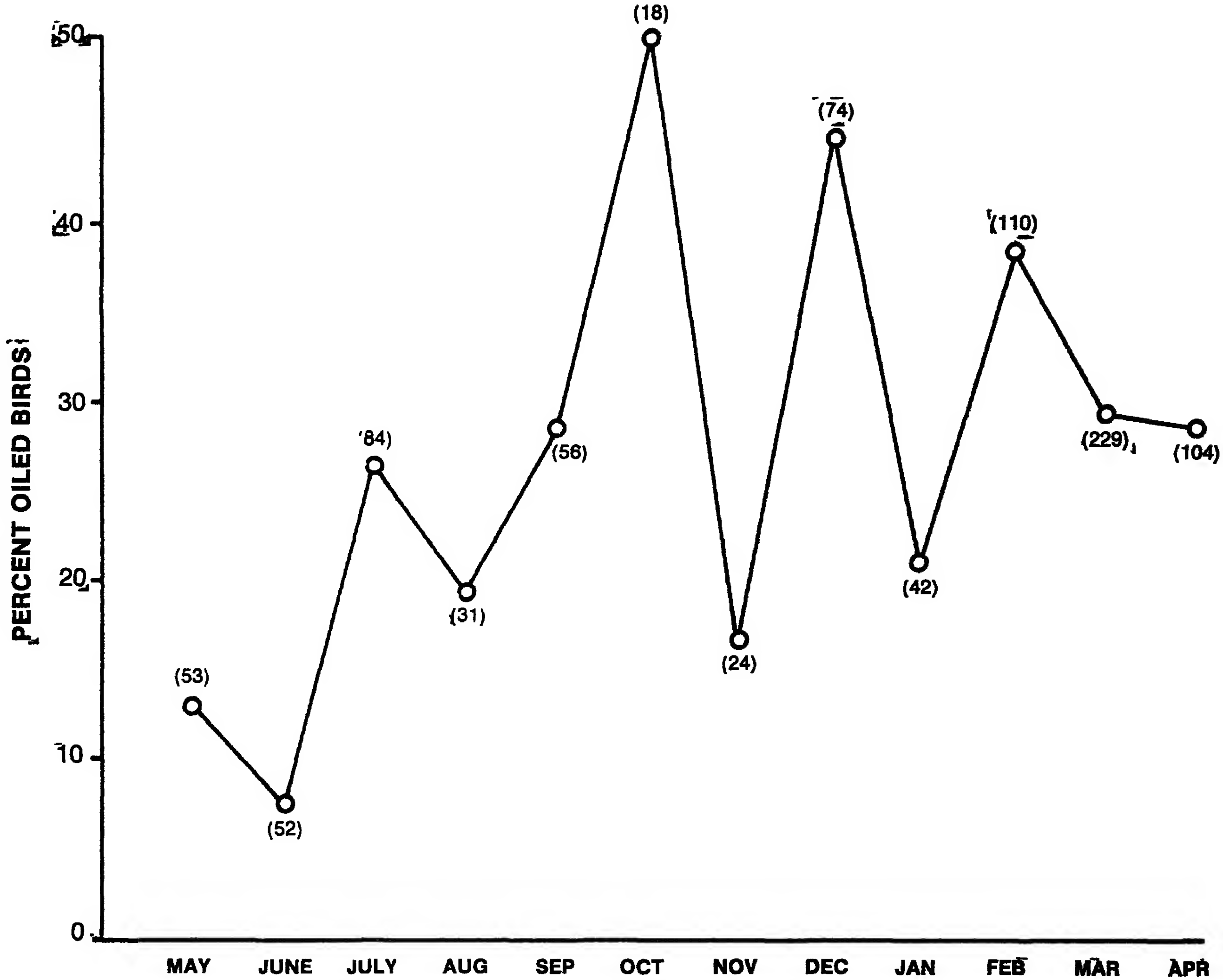


Figure III-247. Percentage of oiled birds from selected southern California beaches, May 1975–April 1976. Sample sizes (n) shown in parentheses.

were alcids, loons, grebes and shearwaters (Table III-152). Oil-soaked birds occurred most often during the winter and spring months, and similar to the pattern found in oiled birds, most oil-soaked birds were found on the shores of the Santa Barbara Channel.

Table III-152. Susceptibility to oiling of several species groups of seabirds as indicated by beached bird surveys. Susceptibility index is calculated as: number oil-soaked/number oiled.

Species group	Number found	Number oiled	Number oil-soaked	Susceptibility index
Alcids	43	25	19	.76
Loons	35	17	12	.71
Grebes	48	16	11	.69
Scoters	19	4	2	.50
Pelicans	11	2	1	.50
Shearwaters	124	42	11	.26
Shorebirds	11	5	1	.20
Kittiwakes	109	31	6	.19
Fulmars	215	69	12	.17
Gulls and terns	198	28	3	.11
Cormorants	39	7	0	-

D. Discussion

The rate of occurrence of beached birds in southern California (1.35/km/month) recorded on our monthly surveys could not be directly compared with figures obtained from the Orange Co. beaches checked every weekday. When the rate of beaching for Orange Co. beaches is calculated on the basis of birds per km surveyed the figure obtained (0.17/km/month) is unreasonably low. On the other hand, if the rate is calculated as if the beaches were surveyed only once a month, then the rate of beaching is unrealistically high for this region (3.60 birds/km/month).

This finding that the apparent rate of beaching is sensitive to the frequency of beach surveys has important implications for both baseline studies and the assessment of damage related to oil spills. For baseline studies, it is clear that the frequency of beach surveys must be held constant if the results of surveys from one place to another or from one year to another are to be comparable.

The problems with the assessment of damage after oil spills are more difficult. During and immediately after a spill many people will remove injured and oiled birds to recovery stations. This would have the effect of magnifying the apparent number of birds killed or injured by a spill as compared to monthly beach checks conducted during baseline work. Although the percent of birds oiled will show an increase after a spill, the absolute magnitude of the effect of the spill will remain difficult to determine. There are two possible solutions to this problem. One possibility is to reserve at least one beach in the area of the oil spill from which

no birds would be removed and census it only on a monthly basis. While politically unpopular (no bird rescues would be allowed), the monthly census would give and accurate estimate of the increase in beaching and oiling over baseline conditions. A second possibility would be to select a restricted number of beaches for daily or weekly surveys during baseline studies. Under these circumstances the rapid removal of birds from the beach subsequent to a spill could be compared with the baseline rates of beaching. The chief drawback to this scheme is the expense of operating daily beach surveys over a wide geographic area.

Oiled birds constituted approximately 28% of the beached birds found in our surveys. A similar fraction of the beached birds found by P.R.B.O. surveys in 1975 in southern California were oiled (D.G. Ainley P.R.B.O., pers. comm.). Surveys of beaches north and south of the Golden Gate (excluding Los Varas and Devereaux Beaches in Santa Barbara Co.) during 1975 showed oiling rates of 3.0% and 25.0%, respectively (D.G. Ainley, P.R.B.O., pers. comm.). On Los Varas and Devereaux Beaches, which are heavily contaminated by chronic natural seeps, an average of 1.22 birds/km/month were found, of which 90.0% were oiled (D.G. Ainley, P.R.B.O., pers. comm.).

The number of oiled individuals of different species should reflect not only the numbers of each species at risk in the immediate vicinity, but also the probability that an individual of a given species will become fouled by floating oil. In this study we have distinguished between oil-soaked birds that were presumably killed by fouling with oil, and birds that appeared to have become oil-fouled

after death. The number of beach-cast individuals of a species that are oil-soaked should reflect the vulnerability (susceptibility x local numbers at risk) of that species to oil-related mortality. The number of oiled individuals provides a measure of the numbers of individuals in an area in which oiling may take place (numbers at risk). The difference between number oiled and number oil-soaked can be used to formulate an index of individual susceptibility (number oil-soaked/ number oiled = susceptibility, see Table III-152).

On the basis of our susceptibility index one can divide the seabirds of the Bight into three groups with markedly different likelihoods of being oil-soaked. The alcids, loons, grebes and scoters fall into a highly critical group, the shearwaters, fulmars and kittiwakes form an intermediate group, and the gulls and terns a low susceptibility group. Our data on shorebirds, pelicans and cormorants may not reflect accurately the susceptibility of these birds. The indices for both shorebirds and pelicans seem unreasonably high, although if pelicans are in fact as susceptible as our index shows, then extreme measures will need to be taken to protect their small California breeding population. The lack of oil-soaked cormorants was surprising, and we would expect these birds to have at least a moderate susceptibility to oil-soaking. The impact of a spill on the populations of these species will depend not only on their susceptibility, but also the numbers at risk and the percentage of the species' population affected by the spill.

The data in Table III-152 reflect the habits of the species involved. All of the species with high susceptibility (except pelicans) spend all of their time on the water's surface and dive for food. Those

in the intermediate category (shearwaters, fulmars, kittiwakes) spend nights on the water, but are generally more aerial, foraging by dipping, plunge-diving or pursuit plunging from the air (Ashmole 1971). The gulls and terns depend chiefly on plunge-diving, and also generally roost on land at nights, so (excepting shorebirds) they are least exposed to spilled oil. For groups like the shearwaters, fulmars and kittiwakes, the large numbers of oiled birds reflect the large numbers of birds dying for other reasons which are fouled by oil subsequent to death.

Seasonal variations in the incidence of beached birds in the present study were apparently related to weather patterns and to offshore seabird abundance. Rates of beaching were highest from February to April (Fig. III-242) when large numbers of wintering and migrating birds were in the area and when weather conditons were most severe. The December mortality peak indicated the effects of the first winter storm on the seabirds in the Bight. Hunters may have also contributed to December beached-bird occurrence as several non-marine waterfowl were recovered from beaches near Mugu Lagoon, around which are located several duck hunting clubs. The low numbers of beached birds in January may reflect the lack of violent storms in that month. The lowest numbers of beached birds were encountered in the autumn months of October and November, after most migrant seabirds had passed through southern California and before wintering populations had fully arrived. Seas remained generally calm until after our mid-November surveys.

Seasonal shifts in species composition of beached birds generally reflected offshore patterns of species abundance. Resident species

such as cormorants and Western Gulls were found in every month, whereas winter visitors such as loons, grebes, kittiwakes and fulmars were conspicuously absent during the summer (Fig. III-243). In contrast, the Sooty Shearwater, which spends the austral winter in northern waters, contributed heavily to the high rate of beaching in July (Figs. III-242 and 244) when they were abundant in the Bight. Later in the summer (August and September) they were less abundant, as their southward migration passed offshore of the Bight (pp. III-547-548 of this report) and correspondingly fewer of this species were found on the local beaches. Post-fledging mortality of juvenile Western Gulls contributed to the moderately high September total (Figs. III-242 and 244).

Black-legged Kittiwakes showed the most striking parallel between offshore and beached-bird counts. Virtually no kittiwakes were seen by our observers offshore from May through November, but when they reappeared in December they immediately began to be recorded on the beached-bird surveys. Peak numbers of wintering kittiwakes were seen offshore from January through March and these numbers were mirrored by the high frequency of beach-cast birds (Fig. III-244).

Northern Fulmars displayed a pattern similar to the kittiwakes, both offshore and on the beaches. Aerial and shipboard surveys conducted at sea during February and March found fulmars concentrated off Pt. Conception, immediately north of Santa Cruz Is., outside the northern Santa Rosa-Cortés Ridge and offshore of San Diego. During this period a large die-off of fulmars and kittiwakes occurred throughout California (D.G. Ainley, pers. comm., this study Fig. III-244). The distribution of beach-cast fulmars in southern California showed the

mortality to be concentrated north of Santa Cruz Is. and in the southern portion of the Bight (Fig. III-248), which corresponded well with the distribution offshore. Our data from daily inspection of certain Orange Co. beaches (Appendix III-A5) show the first indications of the die-off in early February, then tapering through April and May. It is unknown whether the die-off simply reflected the unusually large numbers of fulmars visiting southern California this winter, or if an actual increase in mortality occurred.

No strong seasonality was detectable from our data on oiled birds (Fig. III-247). Seasonal percentages varied between 8 and 50% for oiled, and between 2 and 28% for oil-soaked carcasses, but sample sizes were too small to reveal significant trends.

The variation in the rate of beaching and oiling of birds (Fig. III-246) from one part of the study area to another was predictable on the basis of the known offshore concentrations of birds, the prevailing winds, the location of oil-seeps (Fig. III-249) and heavy shipping traffic. Beaches of the Channel facing the prevailing winds (north and west Santa Cruz Is., McGrath State Beach) showed the highest rates of both beached (2.2 birds/km/month) and oiled birds (48.6%) of any region in the study area. The fact that the highest rates of beaching and the highest rates of oiling were found on the same beaches is most likely a coincidence; large numbers of beached birds would be expected even in the absence of oil slicks. At Playa del Rey and Huntington State Beaches, which have fewer nearby oil seeps, but which are near heavy shipping traffic, the rates of beaching and oiling were 1.26 birds/km/month and 24% respectively. In contrast, at Silver

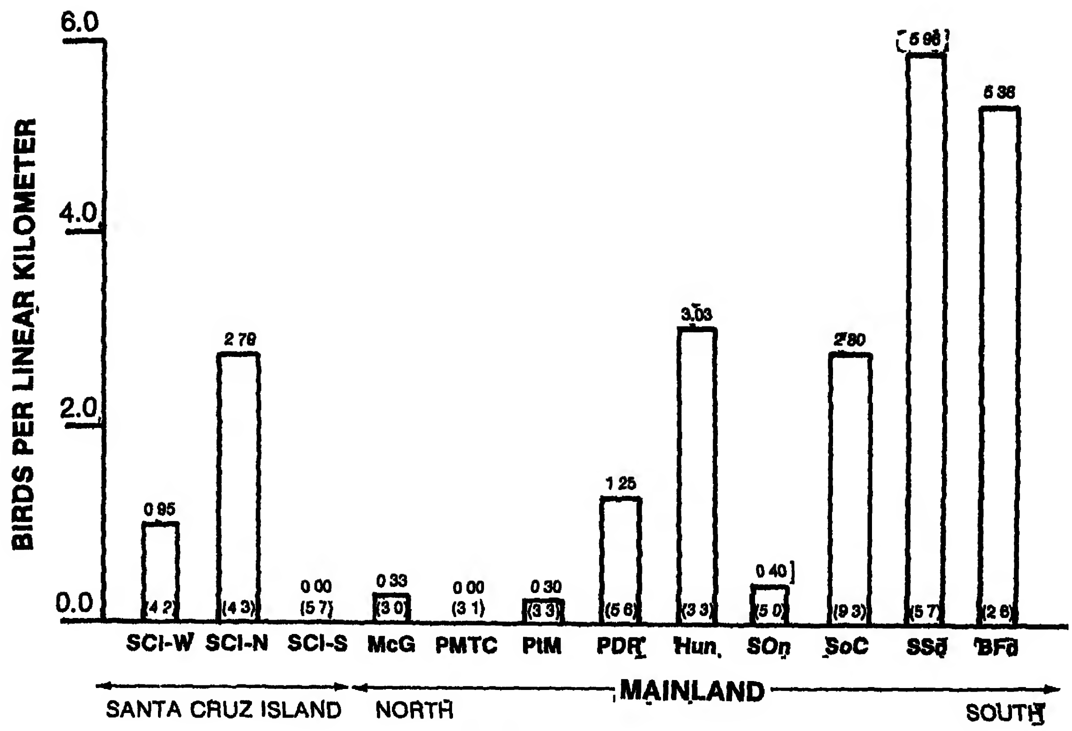


Figure III-248. Occurrence of beached Northern Fulmars (*Fulmarus glacialis*) from selected southern California beaches, March 1976. Beach frontage indicated by parentheses (km). See Table III-149 for key to beach locations.

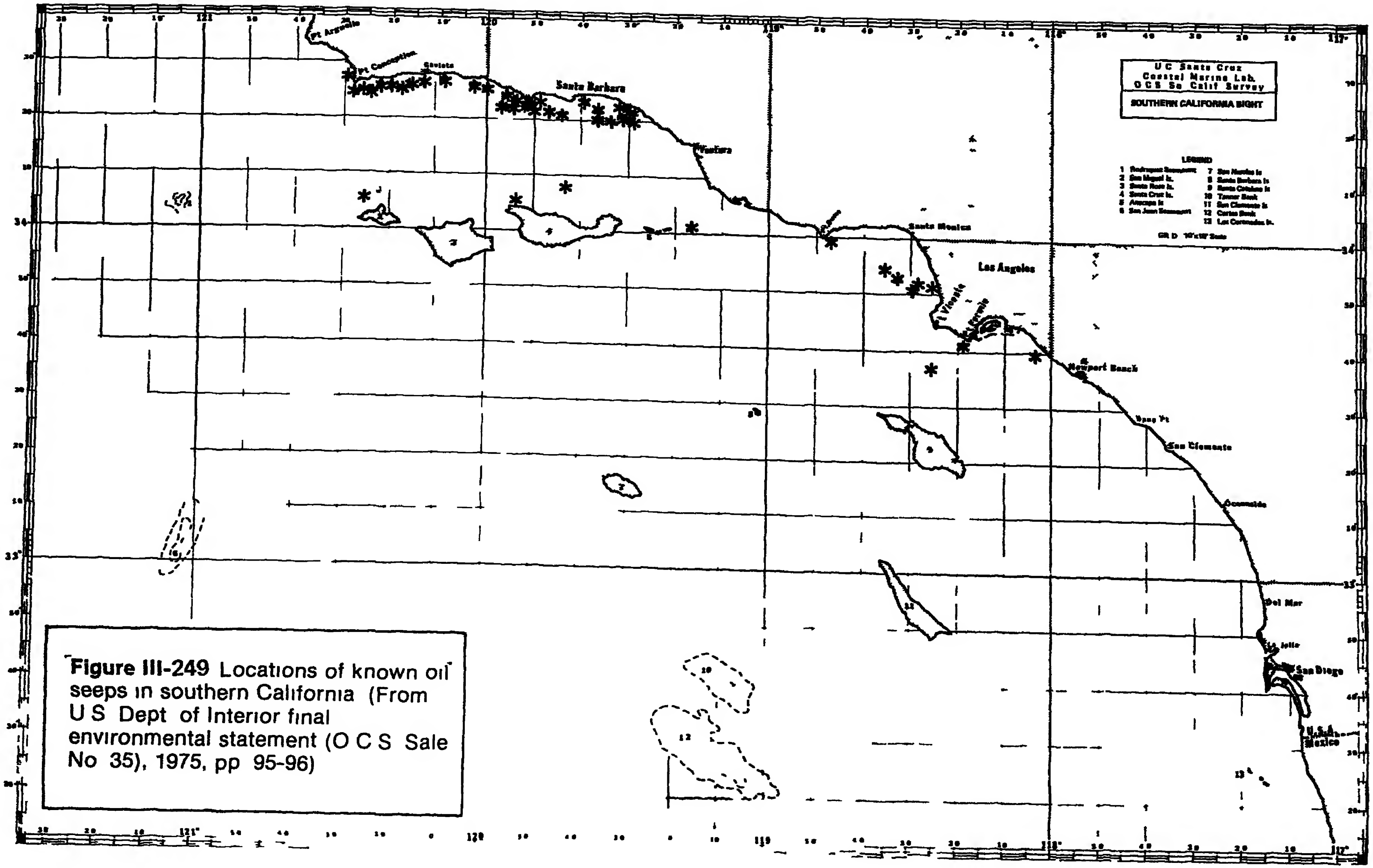


Figure III-249 Locations of known oil seeps in southern California (From U S Dept of Interior final environmental statement (O C S Sale No 35), 1975, pp 95-96)

Strand and Border Field State Beaches, where no nearby oil seeps occur and only moderate shipping traffic is present, the beaching occurred at 1.90 birds/km/month with only 13% oiled. The differences in the rate of beaching undoubtedly reflect the numbers of birds offshore and the drift of birds due to currents and winds. The differences in percentage of birds oiled (which were statistically significant at the $\alpha = 0.05$ level) are most likely the results of the separate contributions to oiling of seabirds made by natural seeps and discharges from ships.

While the occurrence of beaching of some species groups (loons, grebes, alcids) appeared to reflect offshore abundance, the incidence of beaching of other groups (shearwaters) failed to reflect offshore distribution. The percentage occurrence of beached shearwaters was remarkably constant throughout the study area (Fig. III-245) despite the fact that nearshore concentrations of shearwaters were generally greater in the Santa Barbara Channel than elsewhere.

Numbers and species composition of beached birds are significantly affected by important local environmental features such as the proximity to large estuaries. Beach-cast waterfowl and coots were concentrated in the north mainland sector, where the influence of Mugu Lagoon and the associated duck hunting activities were clearly apparent. Estuarine species comprised nearly twelve percent of the birds found in this region. When grebes and scoters, which also tend to accumulate in and near estuaries, are included in the computations, estuary-associated species account for more than a quarter of the beached birds found in the north mainland sector. At all other beaches combined, the proportion was only 4.6 percent, and if grebes and scoters are eliminated from the latter computation, the figure drops to 1.0%.

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